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L AND GAS URNAL

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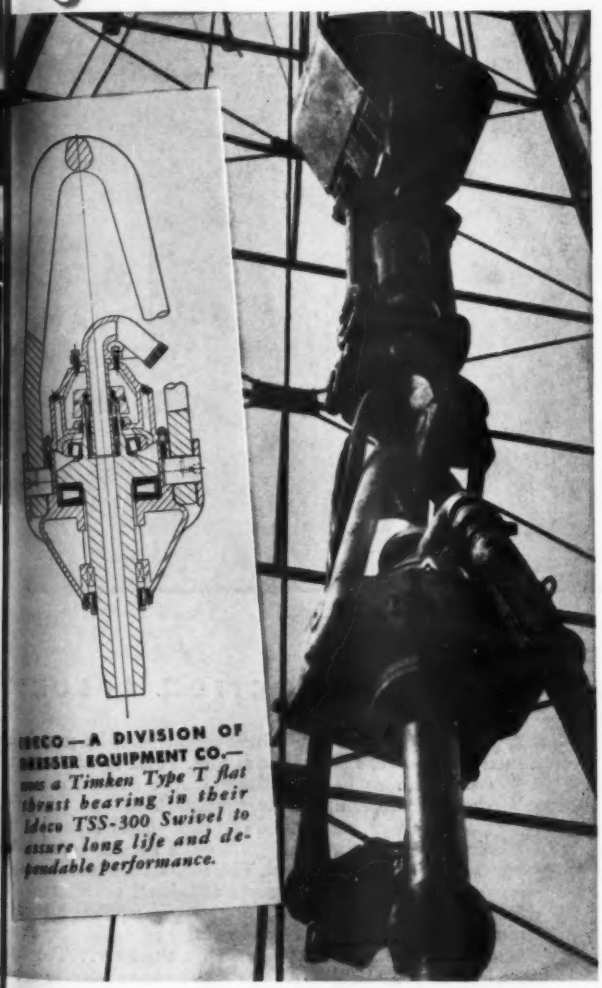
DETROIT

w TIMKEN® bearings hold up the load ...hold down the cost



IDECO—A DIVISION OF DRESSER EQUIPMENT CO.—uses a Timken Type T flat thrust bearing in their Ideco TSS-300 Swivel to assure long life and dependable performance.

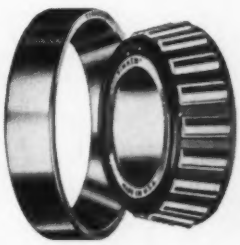
TO carry the tremendous load of the drill string dependably and with minimum maintenance this Ideco TSS-300 Swivel has a heavy duty, on-apex Timken flat thrust bearing in the main bearing position.

Due to line contact between rollers and races, Timken® bearings have extra load-carrying capacity, often carrying strings of drill pipe more than three miles long. The on-apex design gives the bearing true rolling motion—no scuffing or skidding of the rollers on the races.

Made of Timken fine alloy steel, the rollers and races of Timken bearings are case-hardened to provide high wear-resistance. With Timken bearings there's no breaking-in time required, no operating interruptions due to bearing replacement. And Timken bearings require less attention for lubrication—save you both time and lubricant.

Backed by more than half a century of bearing research and development, Timken bearings are first choice throughout industry. Make sure you specify them for the oil field equipment you build or buy. Always look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS



T JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◎ AND THRUST → ◎ ← LOADS OR ANY COMBINATION →◎←

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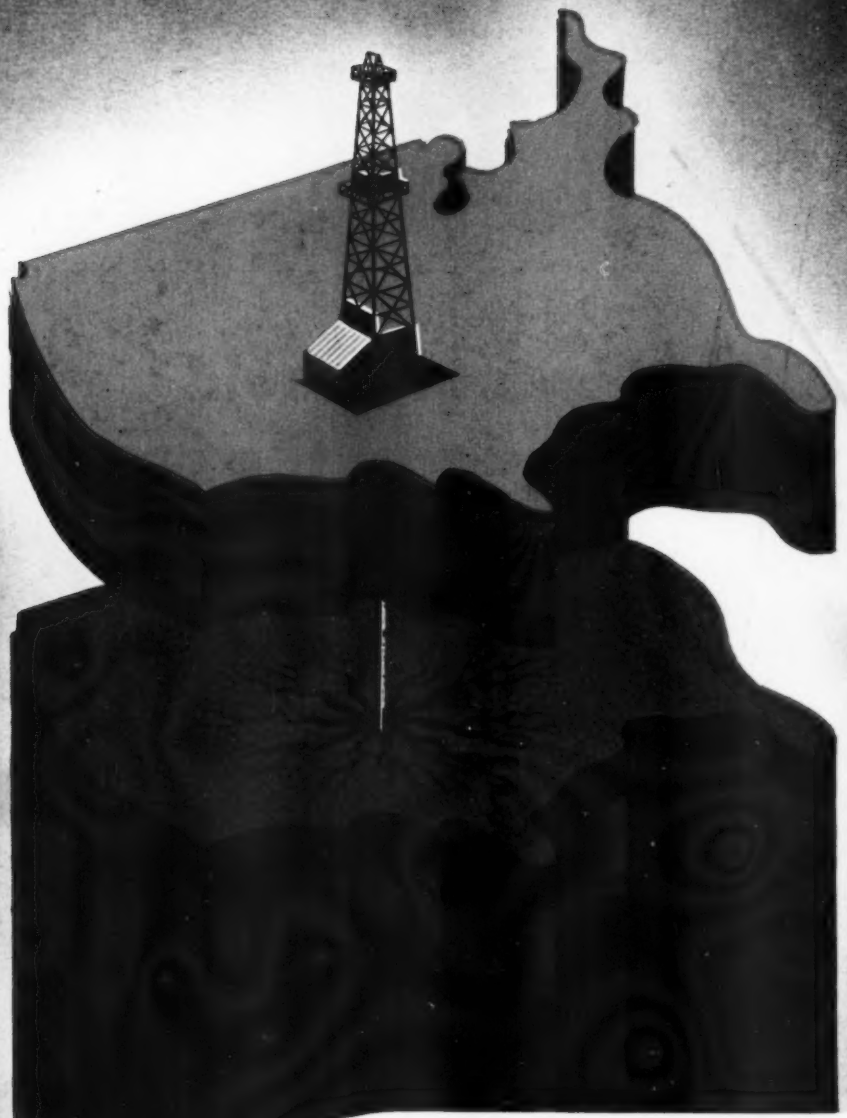
HALLIBURTON



HOWCO

IS "CRACKING" PRODUCTION RECORDS

A growing number of wells have responded with remarkable success to Howco's Hydrafrac service. There is no doubt but that well owners have available here a proved means of increasing production; with very profitable returns... Howco's Hydrafrac service is a method of hydraulically fracturing the producing formation, creating new and greater permeability within the zone being treated. This method was first used successfully in old wells to recover additional oil reserves and increase the production rate. Now it is also well established as a new completion method—and is more economical and convenient while the drilling rig is over the hole... Thorough analysis of your well by Howco will indicate whether or not Hydrafrac Service can help you crack production records. Telephone your nearest Howco representative.

HYDRAFRAC
SERVICE

"THERE'S NO SUBSTITUTE FOR EXPERIENCE IN OIL WELL CEMENTING"

HALLIBURTON OIL WELL CEMENTING CO.

DUNCAN, OKLAHOMA

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✓ CHECK THE QUALITY

✓ CHECK THE PERFORMANCE

The next time you consider pipe for distribution lines, be sure to check the quality and the performance record of Bethlehem Oil and Gas Pipe.

Bethlehem Oil and Gas Pipe provides long, economical service in any location, in any type of terrain. This is because it's a high-quality pipe through and through, and can be made to meet these specifications—API-5Lx42, ASTM A-139, and ASTM A-134.

Bethlehem Oil and Gas Pipe comes in 40-ft lengths, with either beveled or straight ends, and in diameters from 22 in. up to the maximum permitted by shipping clearances. Diameters up to 36 in. have one longitudinal and one girth seam; sizes greater than 36 in. have two longitudinal seams. Welding is done by the automatic submerged-arc process. What's more, our completely-equipped shop has facilities to meet practically every requirement, including grit-blasting, priming, enameling, and wrapping, as well as the making of Tees, Crosses, and related fittings.

Why not look into the possibilities of Bethlehem Oil and Gas Pipe? Additional information is available from the nearest Bethlehem sales office—or get in touch with us at Bethlehem, Pa.

★ BETHLEHEM STEEL ★

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

FABRICATED STEEL CONSTRUCTION

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM OIL AND GAS PIPE

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Southwest Success Story

Today's high-speed civilization plus the reorganization of the Army and Navy for war has put ever-increasing demands on the petroleum processing industry. The oil companies of America have continued to build and expand facilities for producing more and more petroleum products. Today more petroleum is produced and processed in the great Southwest than in any other area in the world.

Brown & Root, a pioneer constructor in the Southwest is justifiably proud of its contribution to the petroleum industry and other industries in this part of the country. Brown & Root offers experienced counsel backed by more than thirty years of successful engineering and construction in the Southwest. A complete knowledge of soil, terrain, people, and climatic conditions will result in faster, more economical completion of any contemplated project. A request from you will put Brown & Root consultants at your service, at no obligation to you.

BROWN-BILT

BROWN & ROOT, Inc. *Engineers - Constructors*

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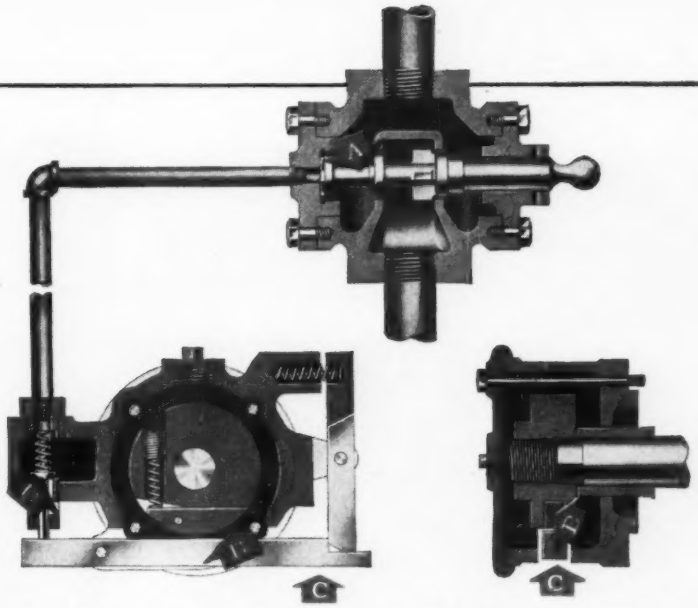
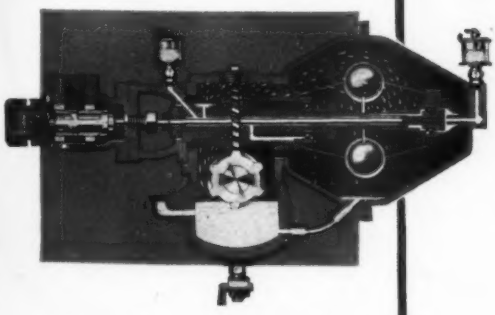
Only Coppus Turbines offer you *a pilot operated* excess speed safety trip



The constant speed governor on Coppus Turbines, plus this Excess Speed Safety Trip, gives you extra protection for your turbine investments. Here's how it works. When steam is turned on, pressure opens valve A fully. When excess speed is reached, centrifugal force throws weight B against lever C lifting pilot valve D. This releases pressure in back of valve A, closing this valve instantaneously, to shut off the steam. Safety trip can be tested easily while turbine is running by manually tripping and resetting lever C.



Sectional view showing lubricating system of fully enclosed Coppus Constant Speed Governor. Governor head acts directly on stem of steam admission valve. No external levers required. Ball bearing construction eliminates end play and gives frictionless operation.

Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes

CUT YOUR COSTS PER HORSEPOWER

When you choose from the Coppus Steam Turbine line, you get the right size for your requirements . . . and make substantial savings on *any* size from the 150 hp turbine down to the smallest. Low in first cost, Coppus Turbines save you more money in the long run. Operating and maintenance costs are kept low by such other features as: large number of steam nozzles, controlled individually by manually operated valves; hard chromium plating on shaft at the stuffing box; replaceable cartridge type bearing housings; optional carbon ring packing assembly for back pressures up to 75 pounds.

WRITE FOR BULLETIN 135

COPPUS ENGINEERING CORPORATION, 265 Park Ave., Worcester 2, Mass. Sales offices in THOMAS' REGISTER.

COPPUS "BLUE RIBBON" TURBINES

Great AMERICANS

Pick the best . . . AMCOT
BULL PLUGS and SWAGED NIPPLES

The extra value you get in AMCOT products is the result of 27 years of special attention to making these standard items better. Write for Catalog 151. Contact your favorite supply store or the nearest American office.

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FORT WORTH 1, TEXAS PHONE VALLEY 2301

NEW CRANE CLASS 600 PIPE LINE GATE VALVES GIVE YOU MANY ADVANTAGES

EASIER OPERATION

TIGHTER SEATING

SMOOTH, CLEAR FLOW

COMPLETE GREASE SEALING

PROTECTED SEATS

For smoother, unrestricted flow . . . for easier, positive operation . . . these new Crane valves are outstanding performers. Developed especially for oil and gas pipe lines, they incorporate many improvements that add up to more years of maintenance-free, fully dependable service. The following are typical advantages of Crane design.

STREAMLINE FLOW—Disc ports align with seat openings to provide smooth passageway when valve is fully open. No turbulence. Least possible resistance to flow. No pockets to accumulate dirt.

LUBRICATED WORKING PARTS. Body packed with grease to reduce friction and wear of internal parts. Grease provides seal at seats, bonnet joint, and stem, which helps maintain pressure tightness.

DUAL-SEATING DOUBLE DISC wedges tight both in fully open and closed positions. Seals off grease from line fluid; protects disc seating surfaces when valve is open.

ACCURATE DISC GUIDING assures correct seating and prevents cramping or binding the stem.

PRESSURE-TIGHT BOLTED BODY-BONNET JOINT. Line pressure forces synthetic rubber "O" ring gasket into wedge-shaped groove in body flange and helps keep the joint tight.

GET THIS NEW CIRCULAR

Gives complete information about these new and better pipe line valves—including essential specification data and service recommendations. Ask your Crane Representative for your copy, or write direct for Circular AD-1864. No obligation!

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
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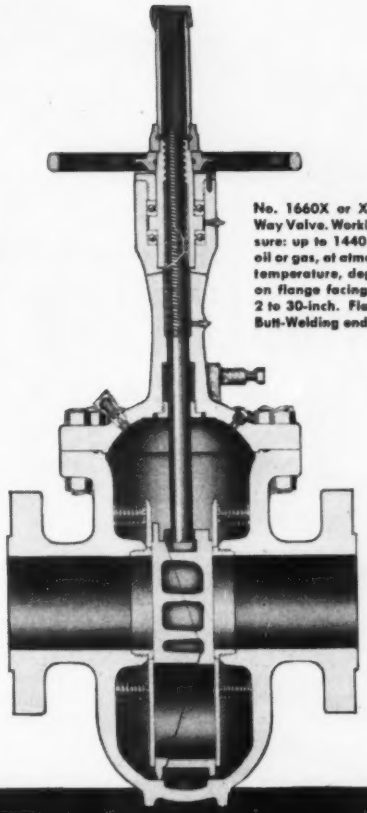
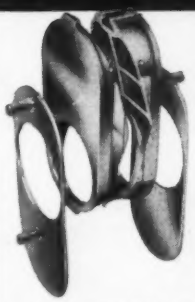


No. 1660X or XH, Full-Way Valve. Working Pressure: up to 1440 pounds oil or gas, at atmospheric temperature, depending on flange facing. Sizes: 2 to 30-inch. Flanged or Butt-Welding ends.

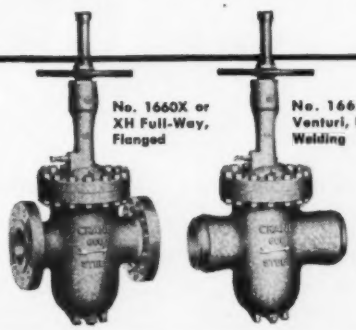
HOW THEY OPERATE



Double disc wedges tightly against shoulder type body seat rings in both open and closed positions. This protects seat faces from erosion and wear.

Movable spring-loaded plates, shown here, retain grease in body and bonnet while valve is being operated . . . also close "conduit" openings in disc against entrance of grease when valve is partly or fully closed.

Only one half of disc is attached to valve stem. At both ends of its travel, the unattached half of the disc comes in contact with stops. Additional wheel rotation then moves the stem-attached half of the disc farther, forcing both discs outward against seat rings and wedging them there.



No. 1660X or XH Full-Way, Flanged

No. 1665XH Venturi, Butt-Welding

EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

The Oil and Gas Journal, published Thursdays by The Petroleum Publishing Company. Entered as second-class matter September 1, 1910, at post office at Tulsa, Okla., under act of March 3, 1879. U. S. and foreign rates to the petroleum industry, $3 yearly. Copyright 1951.

Tip to production men

Ask your Christmas tree supplier for

UNIBOLT FLOW MANIFOLDS

PREFABRICATED AND TESTED

LESS WEIGHT

GREATER STRENGTH

LOWER COST

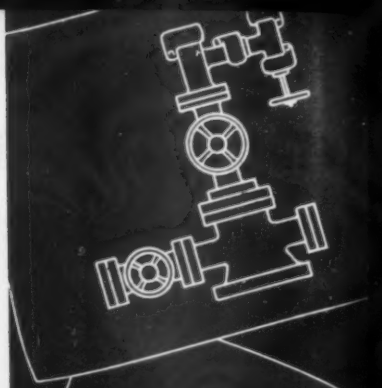
ASSURED DEPENDABILITY

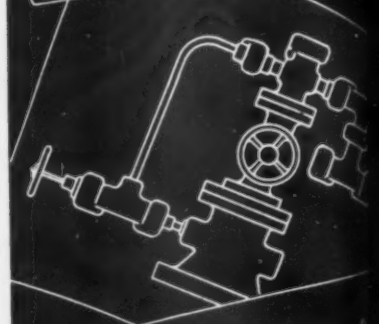
UNIBOLT Flow Manifolds are preferred by many production men because the units of this manifold — Unibolt Adjustable Wing Valve, Unibolt Positive Choke Body, and Unibolt Tee or Cross — may be assembled in a number of combinations to best meet individual requirements . . . The Manifolds are assembled to specifications at the UNIBOLT plant and tested before delivery to your Christmas tree supplier. The Wing Valves can be arranged for flowing with or against the stem, and the Positive Choke Body may be rotated to any desired position to facilitate tying-in with the flowline. It's truly flexible.

Add to this such features as: exclusive "flow-rated" positive beans (regular fractional sizes and "X" sizes) for precise control of well flow, lighter weight, greater strength, lower first cost and maintenance, plus the fact that any of its parts may be safely and easily replaced in the field, and you have the reason why more and more operators are specifying UNIBOLT Flow Manifolds.

Available in regular forged steel or in high — chrome alloy for corrosive wells — 6,000, 10,000 and 15,000 lb. test.

THORNHILL-CRAVER CO.
HOUSTON, TEXAS





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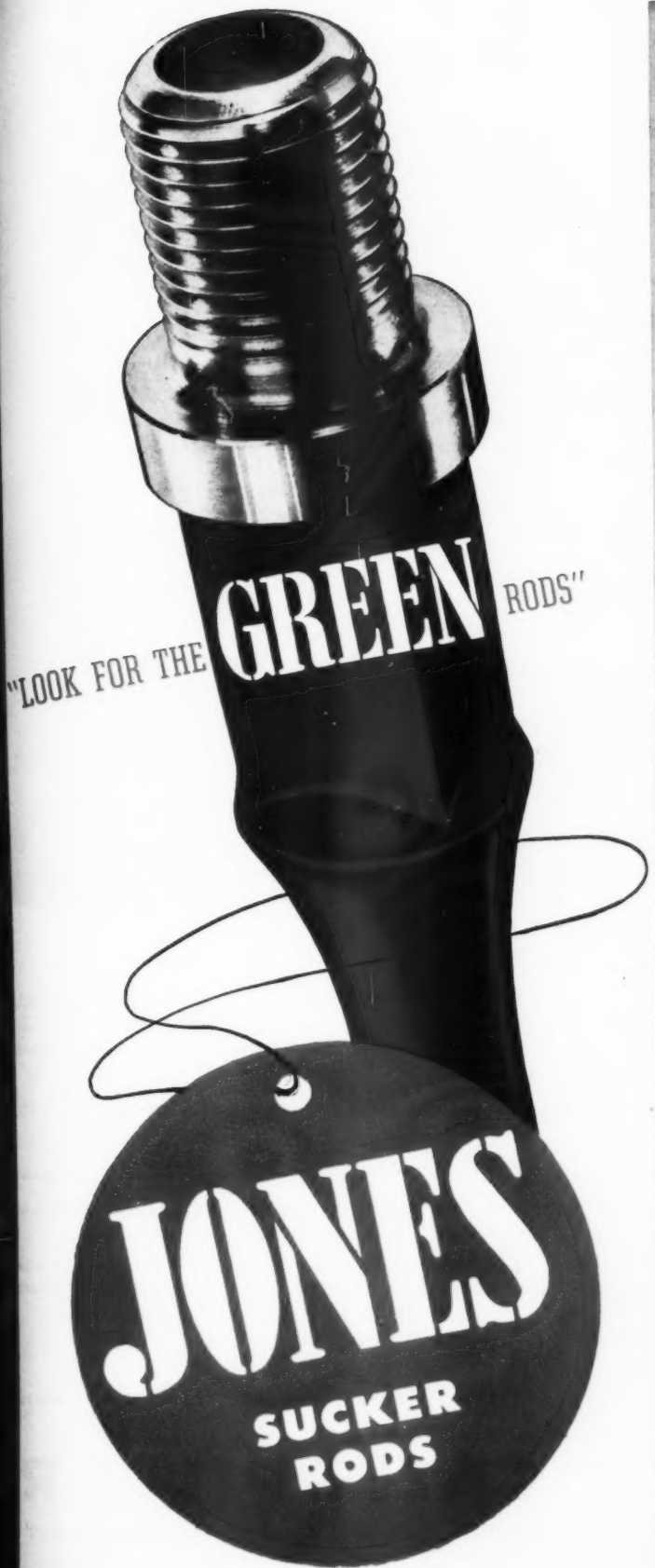

3 WAYS

Jones Helps Improve Sucker Rod Service

1

VISUAL INSTRUCTION. A new sound motion picture has proved a real time and money saver for instructing rod crews, supplier's men and others in correct care and handling of sucker rods. Group showings are arranged upon request.

2

INFORMATIVE LITERATURE. To satisfy the demand for printed information, Jones supplies booklets, folders, catalogs and other material. These are prepared to offer pertinent facts in convenient form. They are useful in the field and help expedite specifying and ordering.

3

FIELD ENGINEERING SERVICE. Constructive suggestions and recommendations of this service provide definite production improvements. Based on the technical skill of experienced field engineers, using precision equipment, it provides a scientific analysis of pumping conditions that result in more production at lower cost.

THE S. M. JONES COMPANY

(Subsidiary of Buffalo Bolt Company)

General Office and Factory: TOLEDO, OHIO

Sales Office: Kennedy Building, Tulsa, Okla.

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"Washington calling!"

We were expecting this call. In a sense it is the people of America on the other end of the telephone. For some time they have been calling upon our government to take whatever steps are necessary to equip our fighting men for any job they may have to do.

Korea has proved the fallacy of limited preparedness. You know now that the nation is girding for survival. The people of America have said—and rightly—that private industry should provide the Armed Forces with whatever is necessary.

Machines are being mobilized. "Caterpillar" products are wearing olive drab once more. Because of large military demands your present machines may have to work longer than you had anticipated.

You can get many extra hours of machine service life if you:

1. **Follow a sound program of operation and maintenance.**
2. **Consult your Operator's Instruction Book, using it as a constant guide in caring for your machines.**
3. **Secure the assistance of your "Caterpillar" dealer who now, more than ever before, is your working partner for the grim job that may lie ahead.**

• • •

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS

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Diesel Engines • Tractors • Motor Graders • Earthmoving Equipment

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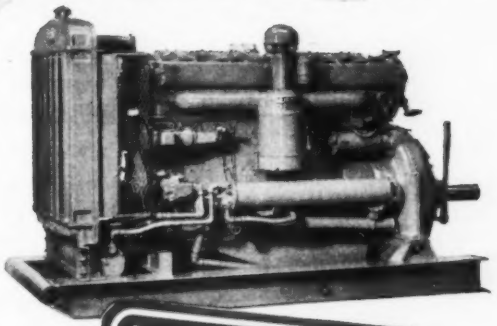


MURPHY DIESEL DEALERS, strategically and conveniently located throughout the United States, are ready to assist you. Backing these dealers are direct factory sales engineers located in the field whose sole purpose it is to aid the dealers in serving you. This complete field organization is fully qualified to help analyze and handle your complete power requirements promptly and efficiently. This is another of the many good reasons for using Murphy Diesel power.

Further, Murphy Diesel simplicity of design and rugged, heavy duty construction means—

More Power — Greater Dependability
Greater Economy — Longer Life

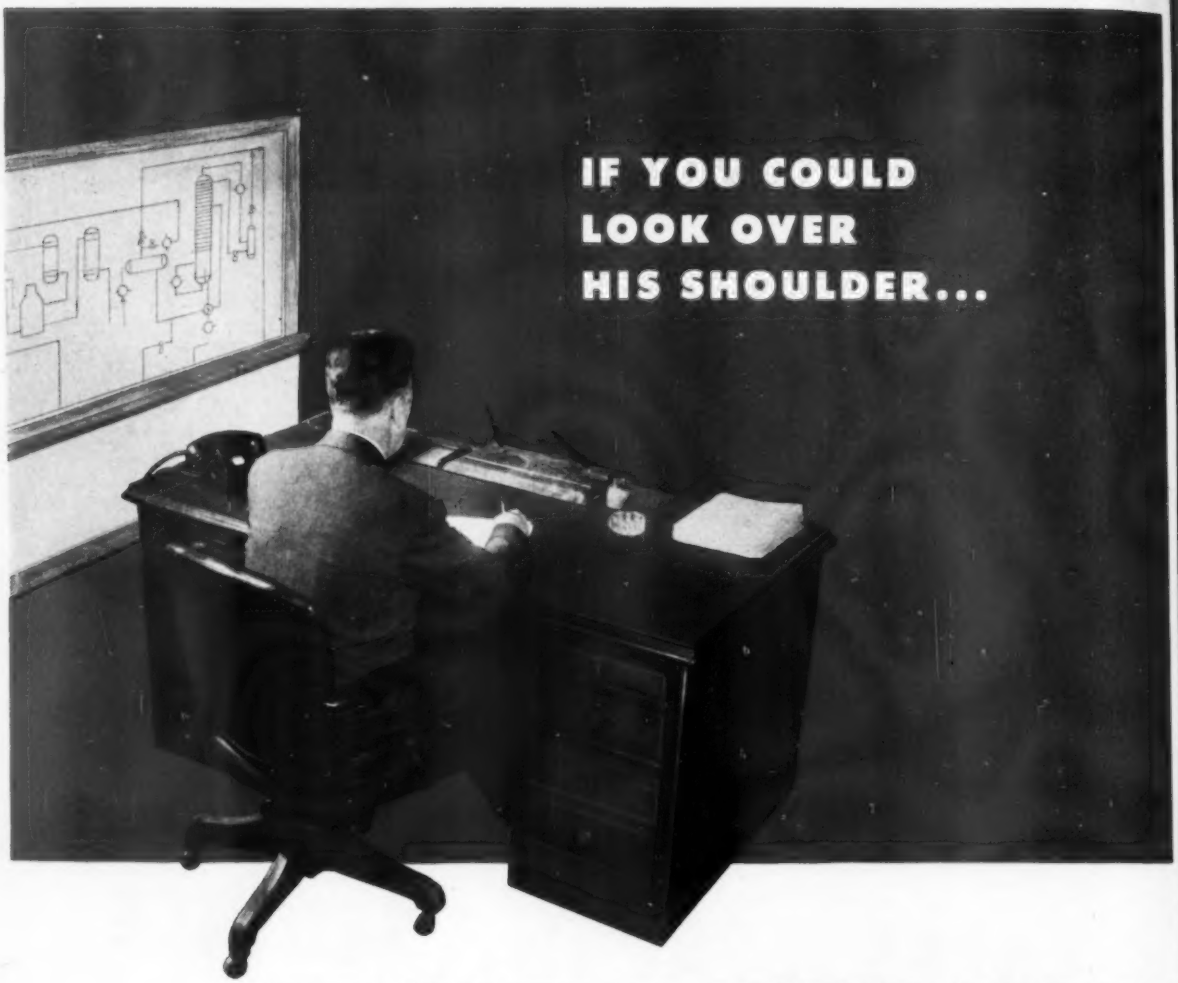
Get acquainted with your Murphy Diesel Dealer, now, and let him show you how Murphy Diesels can deliver more horsepower for fewer dollars. If you do not know your dealer's name, we'll be happy to send it to you.

MURPHY DIESEL COMPANY
5305 W. Burnham St. Milwaukee 14, Wis.

MURPHY DIESEL

Heavy duty power
for all services

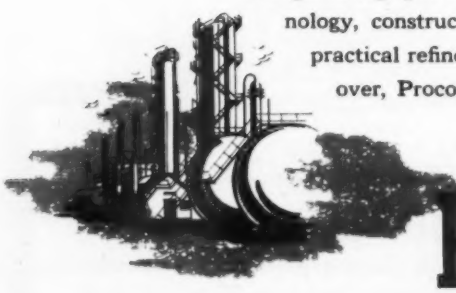
Murphy Diesel engines and power units are made in sizes from 90 to 226 H. P.; generator sets from 60 to 140 K. W.



If you could follow the progress of a refinery construction job as it is handled by the Procon organization . . . watch the work progress from blueprint to finished plant, you would understand why Procon service assures you *maximum value for every dollar invested.*

Here is a balanced organization of highly skilled personnel, thoroughly experienced in engineering, petroleum refining technology, construction know-how and practical refinery operation. Moreover, Procon is directed by an administrative group that has been working together in refinery processing installation and operation for many years. Thus every job receives the over-all benefit of strategic planning and resourceful thinking.

Procon Incorporated offers a complete process construction service in the petroleum refining and petro-chemical industry. The opportunity is here to acquire the services of a capable organization, unusually well-grounded in practical experience and technical knowledge.



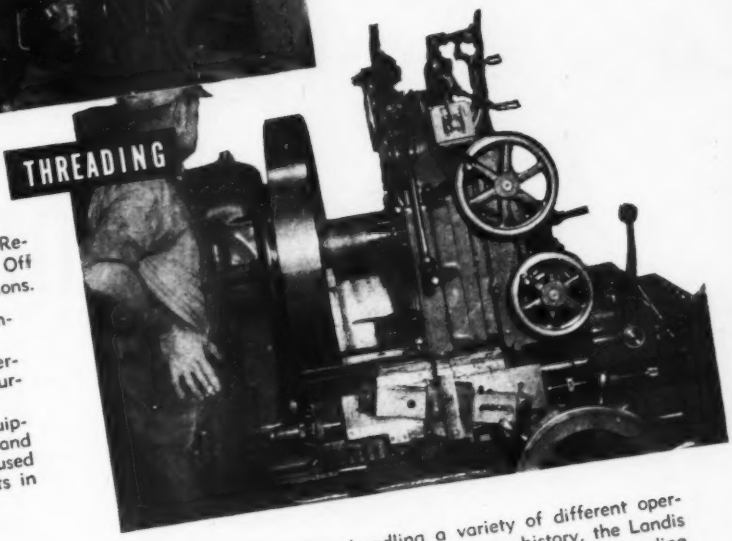
PROCON *Incorporated*

PROCESS CONSTRUCTION

75 EAST JACKSON BLVD., CHICAGO 4, ILLINOIS

More Jobs Per Dollar Invested

LANDIS PIPE MACHINES do many operations for this Texas Company...



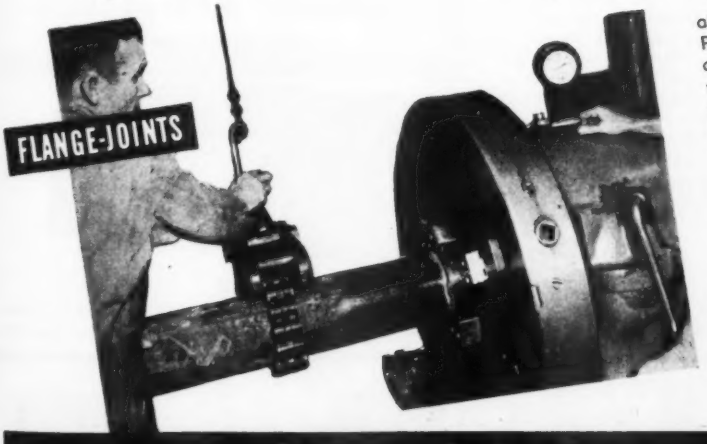
. . . . . saving handling, saving labor, saving machines . . . resulting in dollars saved and dollars earned for this production plant.

Illustrations show the **same** 13⅜" Landis Receding Chaser Pipe Threading and Cutting Off Machine performing three **different** operations.

CUTTING OFF—Casing is cut off, chamfered and then reamed.

THREADING—7" casing to A.P.I. tolerances, using a cutting speed of 18 surface feet per minute.

FLANGE MAKE-UP—Rear chuck is equipped with grip for making up joints and both the front and rear chucks are used for breaking casing or drill pipe joints in oil field work.

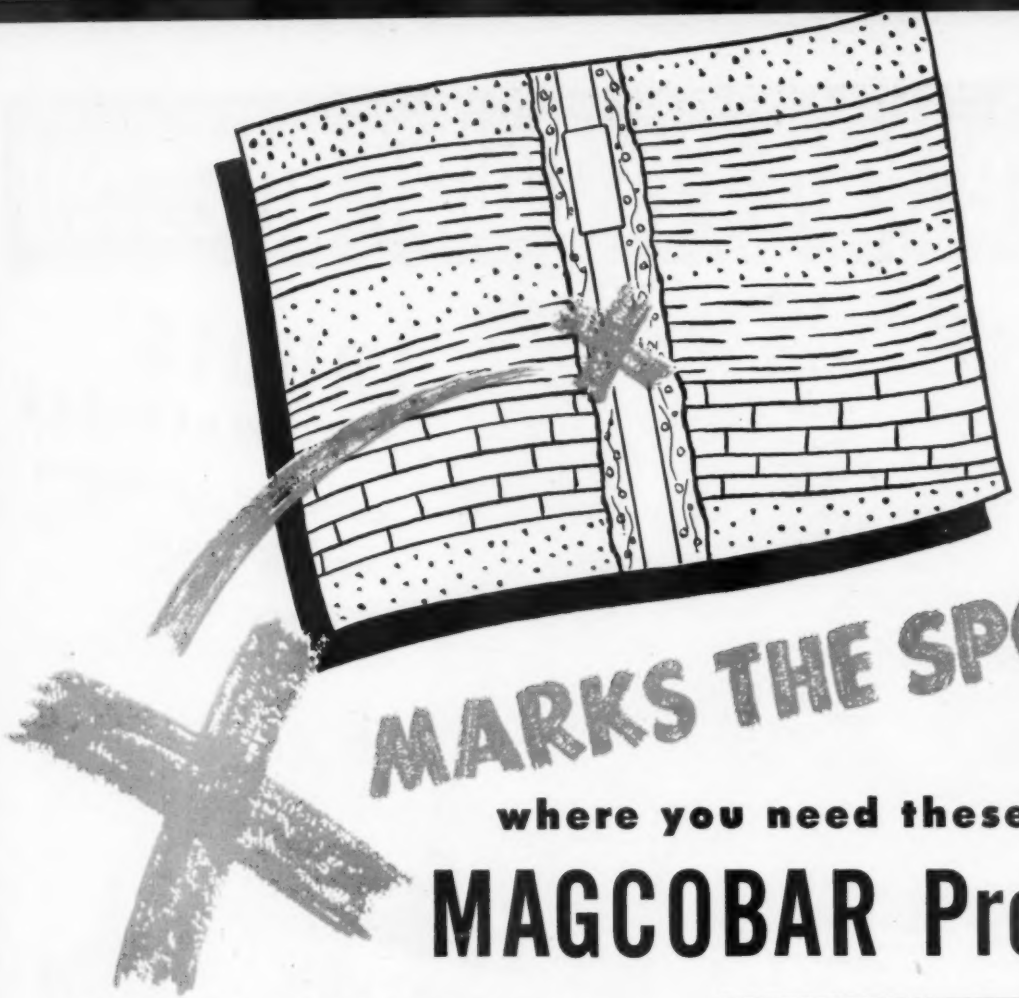


Besides handling a variety of different operations, as shown in this case history, the Landis Pipe Machines offer great versatility in threading operations alone. Each size machine handles a wide range of thread diameters. Within this range, and using the same set of chasers, the machine will cut threads of all diameters having the same taper, pitch and form. In addition, these machines are designed to cut tapered threads to precision tolerances. Accurate taper is assured by the sine bar feature, which causes the chasers to be withdrawn at a rate directly equal to the thread being produced.

Landis Pipe Threading Equipment can widen the gap between costs and selling prices in your plant. For complete details and specifications of Landis Pipe Threading Machines and Landis Tangential Chasers, write for Bulletin #C-77.

LANDIS *Machine* COMPANY · WAYNESBORO PENNSYLVANIA

Represented in the Domestic Oil Fields by: Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; C. J. Harter Machinery, Houston, Texas; Frederic-Baker Co., New Orleans, La.; Moore Machinery Co., Los Angeles and San Francisco, Calif.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.



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where you need these proved

MAGCOBAR Product

MUD THINNING AGENTS

As drilling proceeds through the sedimentary beds of clays, shale and sand, tiny particles of these solid materials enter the drilling fluid. Many of the formation solids picked up by the drilling mud have a particle size that is in the colloidal range. Then, very small amounts of contaminants . . . such as salt or calcium compounds . . . cause these minute particles to agglomerate into a spongy mass. In order to break up the tiny particles so that they act independently of one another instead of as spongy agglomerates, Magcobar has available special materials which chemically disperse these solids. This allows the operator to properly control the physical characteristics and take maximum advantage of the mud-making properties of the formations drilled. This results in a drilling fluid with optimum characteristics as to weight, viscosity, gel strength and wall-building properties. Check with your Magcobar field engineer on how you can take full advantage of the economies possible with Magcobar mud thinning agents. Stocks of Magcobar products are carried in the field by more than 300 Magcobar Dealers, ready to serve you day or night.

MAGNET COVE BARIUM CORPORATION
MALVERN, ARKANSAS • HOUSTON, TEXAS
One of the Dresser Industries

Magcobar
Complete
DRILLING MUD SERVICE
DEALER

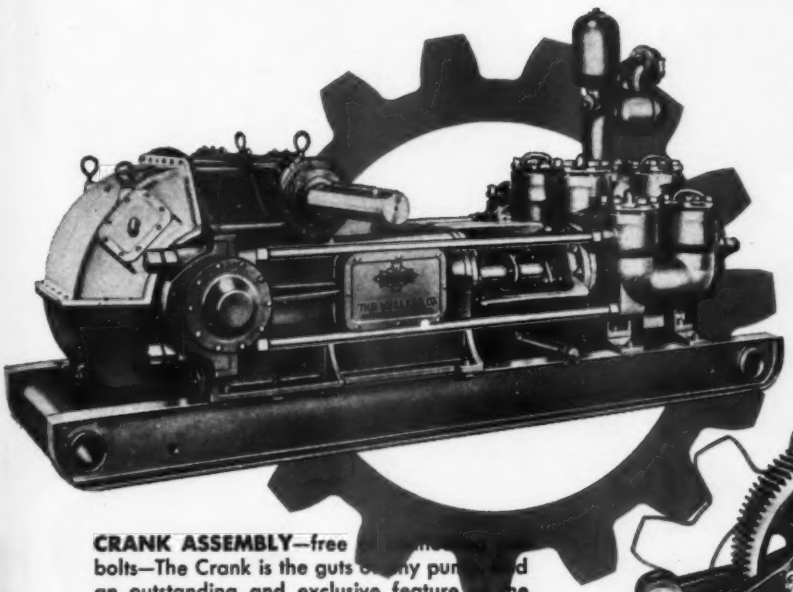
MAGCOBAR . . . THE PIONEER OF FAIR AND REASONABLE MUD PRICES . . . HAS COMPLETED ITS FIRST DECADE OF SERVICE TO THE OIL INDUSTRY

—Lowers viscosity, gel strength and water loss.	—A high quality quebracho extract in powdered form.	—A neutral complex phosphate which is a powerful defloculating agent.	—A pre-dissolved solution of caustic soda and quebracho.

the WHELAND HP-14,000 7½"x14"

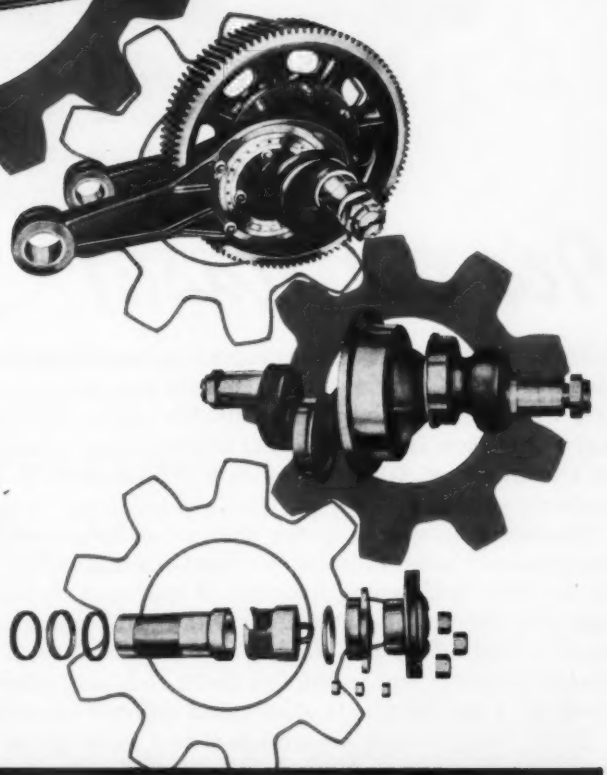
DUPLEX POWER PUMP

with built-in stamina



. . . pays off in long-life, efficiency and low-cost maintenance

CRANK ASSEMBLY—free [illegible] bolts—The Crank is the guts [illegible] pump and an outstanding and exclusive feature [illegible] Wheland HP-14,000 is that its crank assembly is an integral unit without any connecting rod bolts . . . it has a one-piece alloy steel Crank on Timken Roller Bearings . . . its Connecting Rods are of heat-treated alloy steel, fitted to the crank on American Roller Bearings . . . its Helical Gear and Pinion are of tool steel, specially hardened . . . the entire crank assembly is more than ample in size, more than ample in strength, quiet and free of vibration . . . YES, the Wheland HP-14,000 has the built-in guts to do the job.



ONE-PIECE CRANK of alloy heat-treated steel.

LINER AND PACKING RETAINER, exclusive and Wheland patented, has only six nuts to be released for changing, tightening or repacking — turning a time consuming tough job into a quick easy task . . . packing can be tightened while pump is running, saving expensive down time.

LUCEY

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This Simple Compressor Meets the Complex Needs of a Changing Petroleum Industry

It's the Nash!

Here is a compressor presenting advantages found in no other device. Nash Compressors have only one moving part, rotating without metallic contact with the pump casing. No internal lubrication is required. Yet they produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure.

There are no valves, gears, pistons, sliding vanes, or other complicated wearing parts in a Nash. Compression is secured by an entirely different principle of operation. Because of this, gas pumping problems difficult with ordinary pumps are often easily handled by the Nash. For example, Nash Pumps are standard equipment in the Synthetic Rubber Industry, where they have met the needs of new and difficult processes.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. They maintain original performance over long periods. Service is assured by a nationwide net-work of Engineering Service offices. Instructive bulletin shows how they operate. Write for it.

- One moving part.
- No internal wearing parts.
- No valves, pistons, or sliding vanes.
- No internal lubrication.
- Low maintenance.
- Slugs of liquid entering pump do no harm.
- Non-pulsating pressure.
- Saves floor space.
- 75 pounds in a single stage.

NASH ENGINEERING COMPANY
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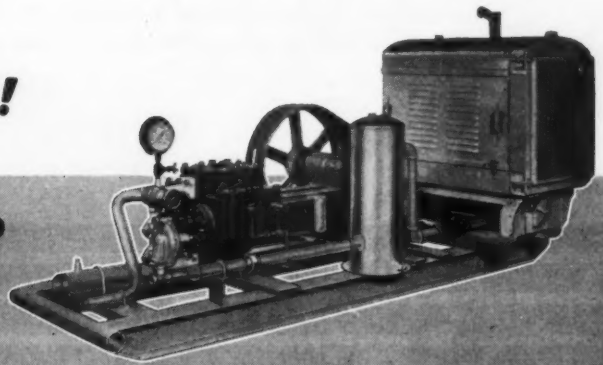
Service... follow-through

It's a smart buyer who looks beyond the purchase of a pump—investigates carefully the long-range service policy of the manufacturer. Gaso welcomes such an investigation. We maintain stocks of parts for all standard Gaso models ever made—with a rule of shipping by fastest route on the day the order is received.

SAY **GASO** AND BE **SURE!**



GASO PUMPS

for every oil industry need

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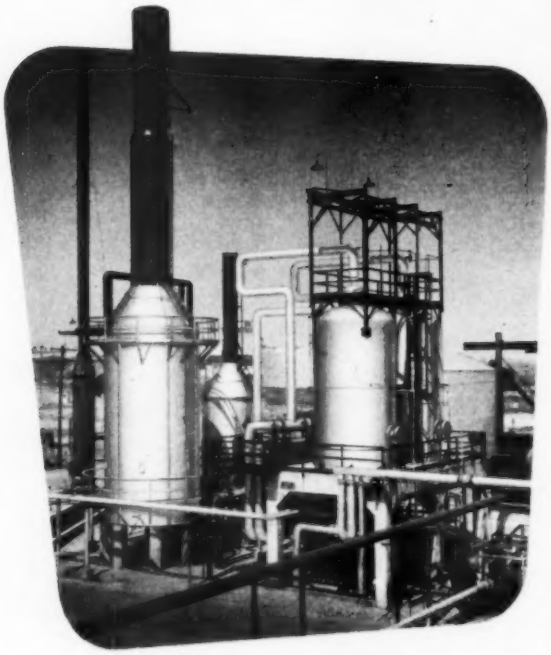

FOR a complete new refinery, or a simple job of modernization, you'll find Koch's 26 years of experience invaluable. This experience is a "plus" that costs you nothing extra. We invite you to "Call on Koch" to discuss your next project.

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And everything you need to produce the well . . . from a Christmas tree to a pumping unit . . . you'll find at that same handy National store.

You'll find something else stocked at the scores of National Supply stores from Alberta to the Rio Grande . . . helpfulness and service. There, the expert store crews and the field service men can help you pick the right type and size of equipment to meet your particular needs.

You'll be among familiar brands at National . . . National and "Ideal" machinery, Superior engines, Spang tubular products, and the famous brands of many other manufacturers.

Convenient supply stores everywhere there's oil-drilling and producing activity is another time- and money-saving service of The National Supply Company . . . world's largest builder and distributor of a fully-integrated line of oil-country machinery.

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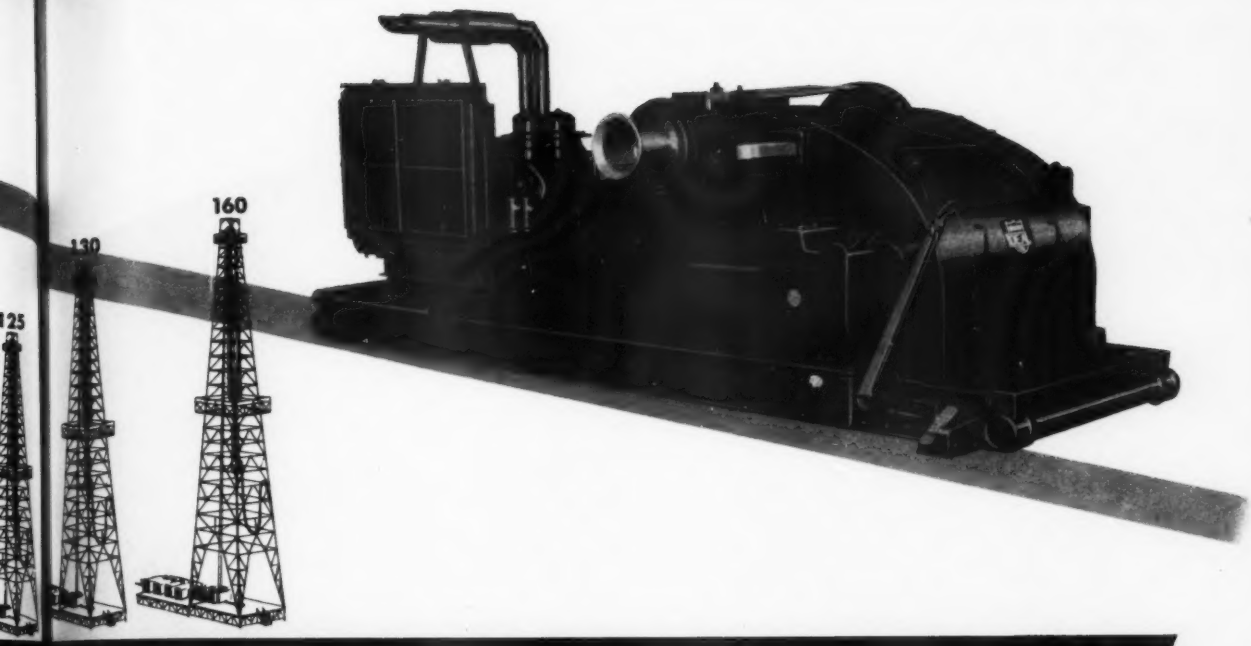

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National offers a choice of eleven models of "Ideal" Rigs. From this extensive family you can select the right rig for your specific drilling or work-over requirements.

"Ideal" Rigs combine field-proved design with precision manufacture and conservative ratings for an extra margin of safety. Sizes range from 80 horsepower, to handle shallow drilling, to 2010 horsepower to drill the deepest holes.

You will also appreciate National's complete field service and extensive stocks of supply and replacement items conveniently located in all United States and Canadian oil fields.

Tell us your drilling requirements . . . we'll send descriptive bulletins on the correct "Ideal" Consolidated Rig to use.

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WITH
HIGH-JOINT-STRENGTH CASING
USE SPANG EXTREME LINE

With today's high well pressures and deeper drilling, you need that high strength found in every Spang Extreme Line Casing joint.

Modified Acme type threads on Spang Extreme Line Casing provide a highly efficient interlock that overcomes any tendency of mating threads to slide out of engagement under heavy loading, The integral streamline joints react to the load as a unit instead of tending to separate.

Spang Extreme Line Casing has only half as many threaded connections as conventional threaded and coupled casing. Hence, there are only half the number of points where leakage could occur.

Your crews can run Spang Extreme Line Casing faster . . . minimum O. D. streamlined joints reduce danger of hangups . . . threads are designed for easy stabbing and tight make-up with fewer turns.

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Jet Eductors Handle Gasoline Dyes For Standard Oil of California

Condensed from ETHYL NEWS with permission of Ethyl Corporation.

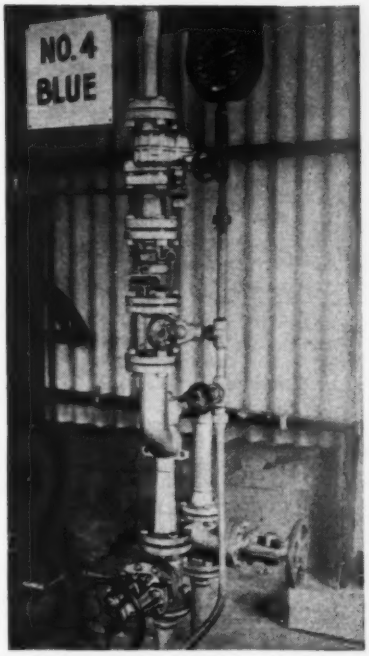
A system for handling light, easily scattered, and extremely penetrating gasoline dyes which has attracted considerable interest among refiners is that installed by the Standard Oil Company of California at its El Segundo refinery. This system makes use of SK 1½" Fig. 222 Jet Eductors to transfer the dye, with the gasoline blend serving as the motivating, or driving, fluid.

A container of dye is placed on a scale and weighed. If, for instance, 300,000 gallons of motor fuel are to be dyed, and the dye requirements are 1.5 grams per 100 gallons, then 4,500 grams or about 10 lbs. of dye are necessary. With the proper color dye on the scale, the operator notes its weight and the reading at which he should stop the addition of dye. He inserts a flexible hose into the dye container, opens the eductor valve, and draws the proper amount from the container. After the required amount of dye has passed through the eductor, "wash" gasoline is flushed through the eductor and its connecting lines to clean them. The balance of the mixing operation—to obtain a proper proportion of dye to gasoline—is completed in the storage tank.

Separate eductors are used for each color of dye in order to avoid improper mixing. In addition, this system allows the use of individual scales for each color permitting the use of sensitive scales and avoiding the necessity for multiple handling of dye barrels.

Standard of California has found a number of advantages in its system. Dyes can be weighed accurately and added to gasoline without spilling. Time is saved by avoiding the intermediate step of making dye solutions. Turbulence in the eductor and loop lines provides sufficient mixing to put the dyes into solution. And, the system provides ease in operating and cleaning, adequate facilities for storing and handling dyes, and economical operation.

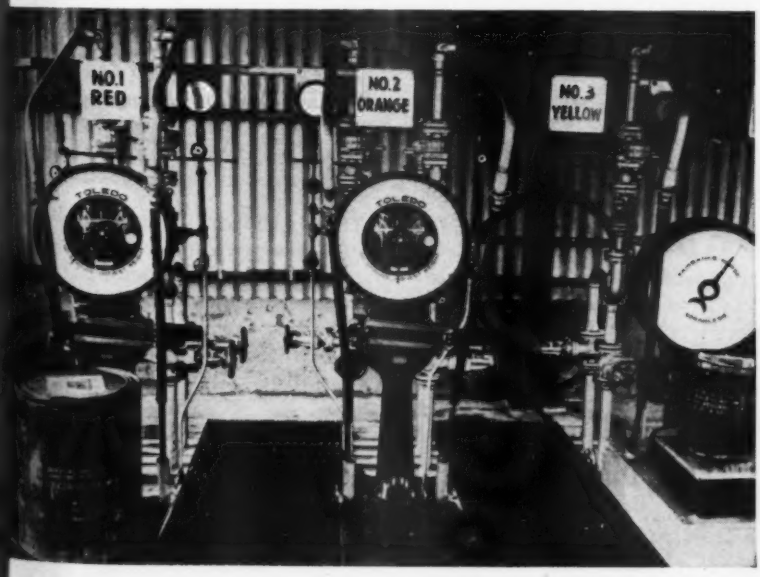
For complete details on SK Jet Eductors, request Bulletin 2-M.



◀ Closeup of an SK Fig. 222 Jet Eductor as used in Standard Oil of California's Dye Handling System.

BULLETIN ON HEAT TRANSFER

SK Bulletin HT-1 pictures and describes standard heat exchangers, generator air coolers, feed water heaters, oil heaters, straight tube evaporators and duplex strainers. Dimensions for various sizes are included in tabular form. Copies available on request.



◀ Photo shows three of the dye eductor manifolds with adjoining scales.

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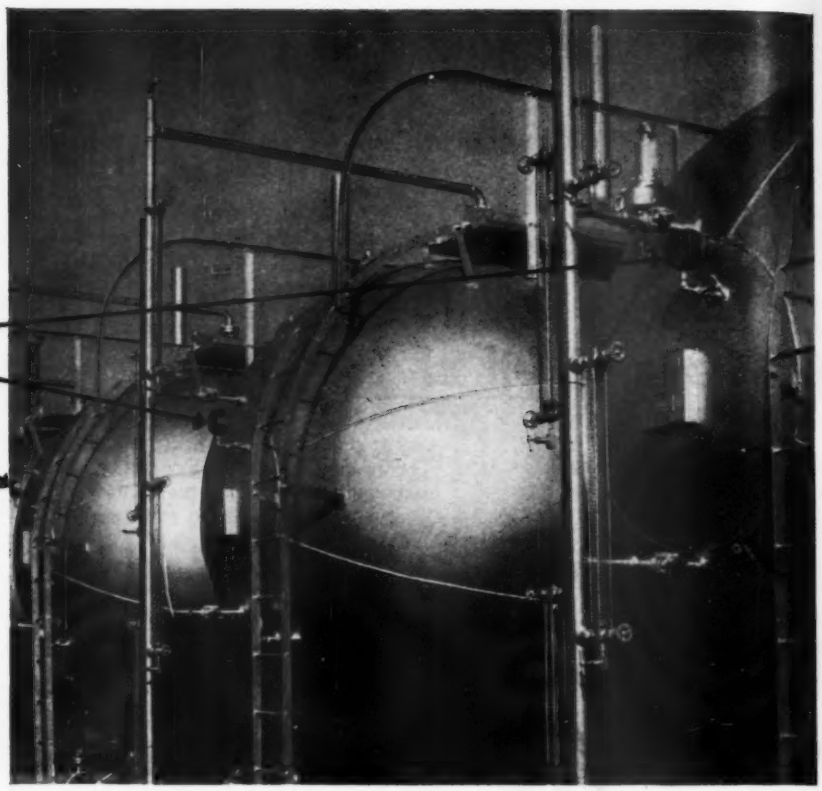
DURAGAUGE SPECIFIED!

Ashcroft Duragauges installed on spherical propane storage tanks at Carthage, Texas.



DURAGAUGE *Nylon Movement** OUTWEARS ALL OTHERS!

How to increase *wear resistance* in a pressure gauge was a stubborn problem—until Ashcroft engineers solved it. Now *only* the Duragauge has a Nylon Movement, *the movement that outwore all others* in extensive laboratory and field tests on the worst services to be found.

Ashcroft engineers recognized the value of lightness and the other characteristics of nylon and anodized aluminum and designed these materials into precision mating parts for the Duragauge. Result: low friction, high impact absorption, corrosion resistance and freedom from objectionable products of wear. Furthermore, the nylon pinion gear and bearings retain their precise form and shape under high temperatures. Consequently, the Nylon Movement provides greatly improved indication sensitivity and accuracy and longer life.

The Ashcroft Duragauge, with Nylon Movement, has proved its enduring dependability in new and old refineries, chemical plants and power stations. It is the unqualified standard for the most "killing" services.

Your Ashcroft Distributor will gladly give you complete facts about the Duragauge and how it can solve your pressure indicating problem.

*Pat. Applied for

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A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

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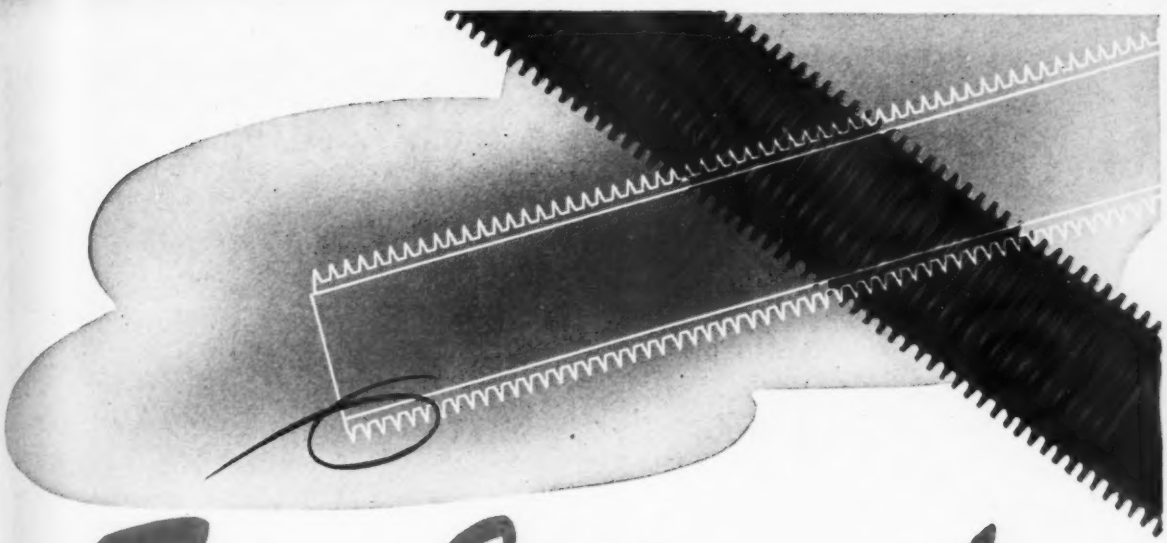

Fins Integral are important

By providing more surface area in the same tube length, Wolverine Trufin* condenser tubes help to conserve tubing. You use less compared to plain surface condenser tubes.

The increased surface area of Wolverine Trufin also permits more economy in producing most petroleum condensates.

With the fins integral with tube itself Trufin condenser tubes can withstand vibration, they can be easily cleaned and the tube lasts longer. Retubing and "shut down" time is reduced appreciably.

In these days when the conservation of men, metal and machines is vital, Trufin condenser tubes can reflect both improved efficiency and economy. Would you like our Technical Bulletins describing this unique finned tube? Ask for them on your company stationery.

*Reg. U.S. Pat. Off.

WOLVERINE TUBE DIVISION
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Manufacturers of seamless, non-ferrous tubing
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Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ont.

Wolverine condenser tubes stocked by Butler Industries, Inc.
355 So. Fourth St. Beaumont, Texas Tel: Beaumont 5-2351

PLANTS IN DETROIT AND DECATUR, ALA.
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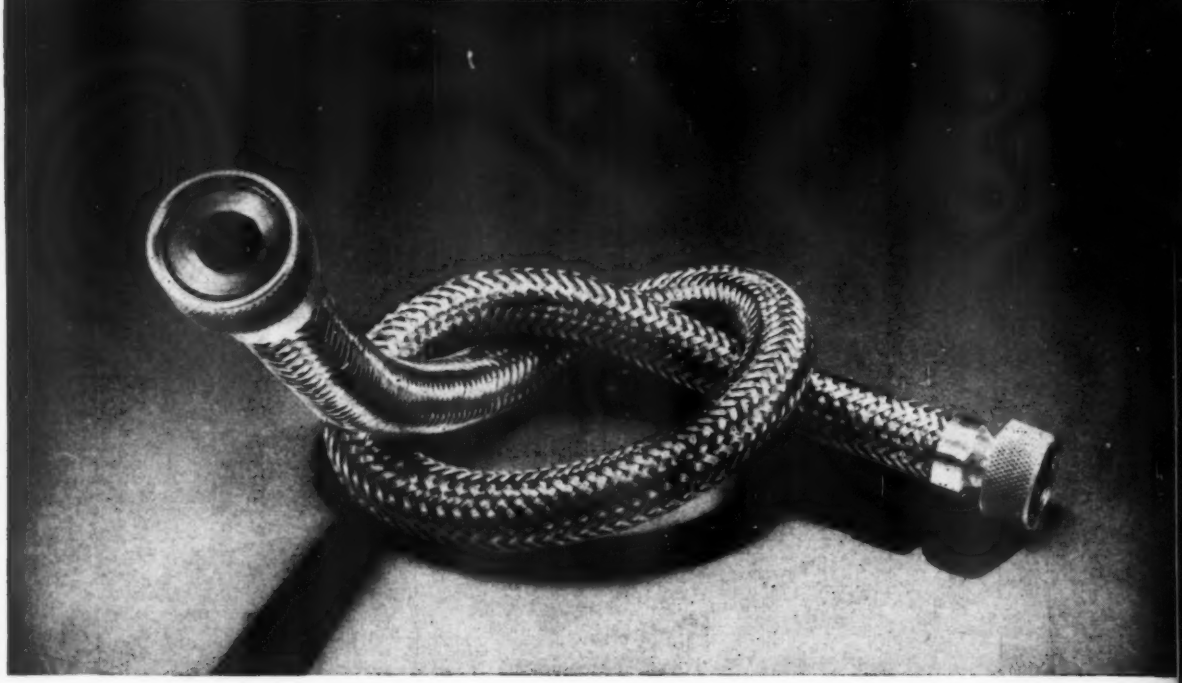
this is CMH REX-FLEX
flexible stainless steel hose



While the need rarely arises, tying CMH REX-FLEX into a knot does illustrate the high degree of flexibility of this *all-metal* corrugated stainless steel hose. And the same characteristics of stainless steel that make REX-FLEX so flexible also give it the ability to withstand extreme cycles of vibration, flexation and variplane motions.

Light in weight...high in strength... leak-proof . . . and highly resistant to corrosion, REX-FLEX is the answer to the problems of handling searching and corrosive liquids and gases where there is motion.

CMH REX-FLEX is made in sizes from 5/16″ through 6″ I.D. Wall thicknesses from .003″ in single ply to .030″ in multiple plies. Available with helical or annular corrugations, with or without metal braid covering. Ends may be flanged or equipped with fittings to meet your requirements. Write for complete information.

Flexon identifies CMH products that have served industry for over 49 years.

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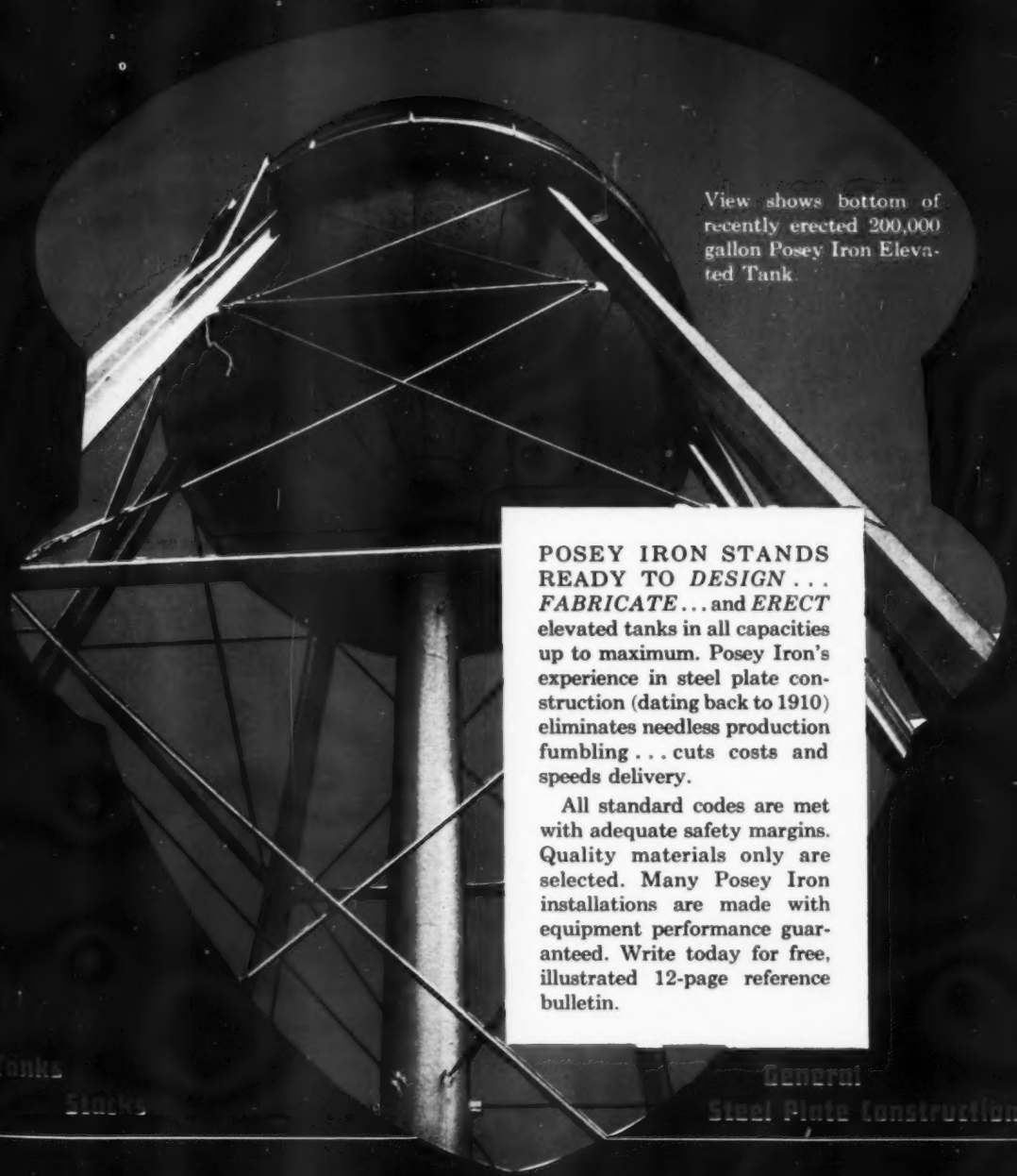
WORMS EYE VIEW OF SAFE STORAGE



View shows bottom of recently erected 200,000 gallon Posey Iron Elevated Tank

POSEY IRON STANDS READY TO *DESIGN* . . . *FABRICATE* . . . and *ERECT* elevated tanks in all capacities up to maximum. Posey Iron's experience in steel plate construction (dating back to 1910) eliminates needless production fumbling . . . cuts costs and speeds delivery.

All standard codes are met with adequate safety margins. Quality materials only are selected. Many Posey Iron installations are made with equipment performance guaranteed. Write today for free, illustrated 12-page reference bulletin.

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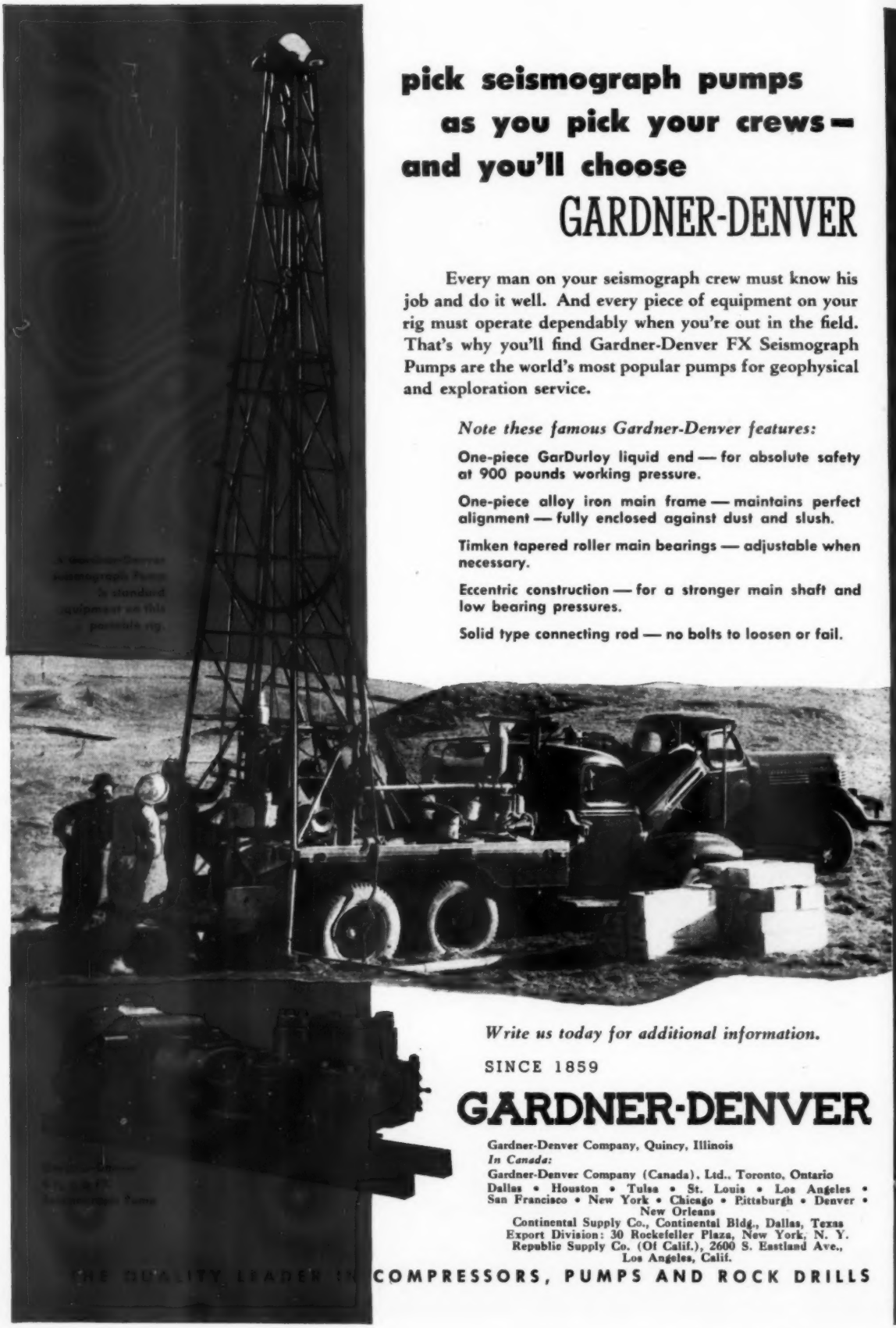

pick seismograph pumps as you pick your crews — and you'll choose GARDNER-DENVER

Every man on your seismograph crew must know his job and do it well. And every piece of equipment on your rig must operate dependably when you're out in the field. That's why you'll find Gardner-Denver FX Seismograph Pumps are the world's most popular pumps for geophysical and exploration service.

Note these famous Gardner-Denver features:

One-piece GarDurloy liquid end — for absolute safety at 900 pounds working pressure.

One-piece alloy iron main frame — maintains perfect alignment — fully enclosed against dust and slush.

Timken tapered roller main bearings — adjustable when necessary.

Eccentric construction — for a stronger main shaft and low bearing pressures.

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SINCE 1859

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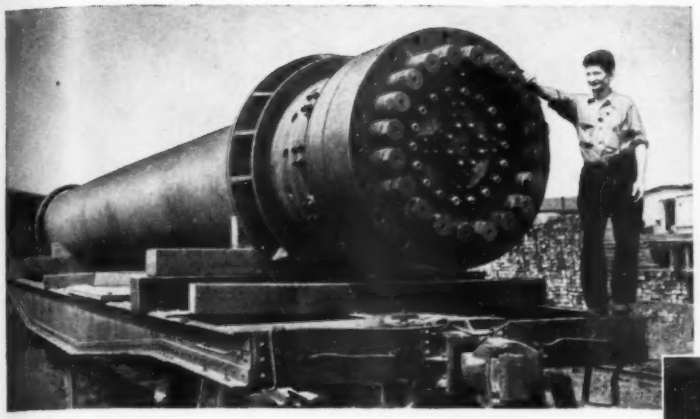
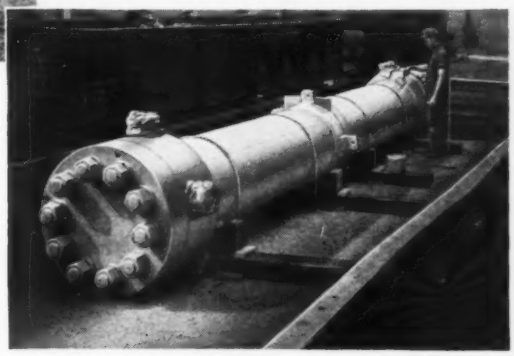
THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS



One of several MULTI-LAYER Converters designed for 5000 psi working pressure, with corrosion-resistant type 405 alloy inner shell. Wall thickness 8¾ inches, weight 182,000 lb. This type of construction is ideal for high pressure synthesis of coal and shale.

MULTI-LAYER Heat Exchanger designed for 5100 psi working pressure. Wall thickness 4¾ inches, weight 45,800 pounds.



A.O.Smith
MULTI-LAYER
Heat Exchangers & Pressure Vessels

The practical, *economical* solution to your high pressure process and storage requirements

MULTI-LAYER vessels are built-up from concentric layers of relatively thin steel plate, progressively *wrapped, tightened* and *welded* around an inner, pressure-tight cylinder.

Greater range of process possibilities for the planning and design engineer are provided in this unique, patented construction.

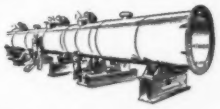
Walls can be made stronger merely by increasing strength of steel wrapping plates or by adding more layers.

For corrosive service, only the inner cylinder need be fabricated of alloy or non-ferrous materials.

No size or weight limitations as MULTI-LAYER vessels or heat exchangers can be made in any diameter for which satisfactory end closures are available.

The full calculated strength of the steel is more fully utilized in MULTI-LAYER vessels. Wrapping tension and weld shrinkage develop compression in the inner layers. This results in more equalized loading of all portions of the vessel wall under working pressure.

Safety is greatly improved by MULTI-LAYER construction. Only the inner cylinder need be pressure tight! Outer layers are provided with vent holes which protect the vessel against damage from over-pressure. In the remote event of run-away overload sufficient to cause failure, there is little danger of fragmentation of the vessel wall, due to the nature of MULTI-LAYER construction.



Consult A. O. Smith for assistance on your heat-exchanger or pressure-vessel problems. In any event, write for Bulletins V-52 and V-53 for more complete information on MULTI-LAYER Pressure Vessels and their construction . . . or use handy coupon.

A.O. Smith 77th ANNIVERSARY 1874 - 1951

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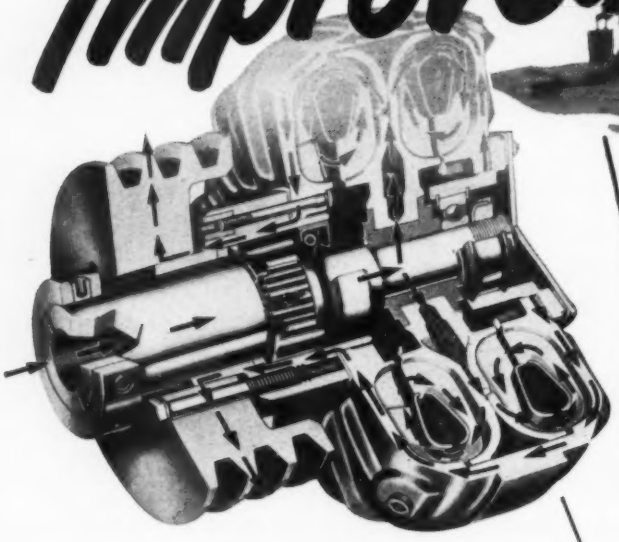

At left, cutaway of a Twin Disc HYDRO-SHEAVE DRIVE.

with an easy-attached Twin Disc HYDRO-SHEAVE DRIVE

A HYDRO-SHEAVE DRIVE is easily attached in a few minutes, mounts in the normal sheave position.

By replacing the ordinary pulley on your pump drive with a Twin Disc HYDRO-SHEAVE you can immeasurably improve the performance of your electric motor.

The *smooth* pick-up of the HYDRO-SHEAVE, so characteristic of all Twin Disc hydraulic units, knocks down the peak wattage demand by an electric motor, to nearer the running load. One test indicated that peak wattage was reduced from 3,000 watts with an ordinary drive to only 2,000 with a HYDRO-SHEAVE Drive.

On another installation, the power-factor was increased from .626 to .748 under running conditions—an improvement of 25%. And this smoothness is reflected throughout the entire mechanism. Stresses and strains in gear box and polish rods are reduced. Motor speeds remain nearer constant and the "slip" of the HYDRO-SHEAVE keeps high peak surges off the line.

A HYDRO-SHEAVE takes only a few minutes to install. It improves the power-factor, cuts down stresses on the sucker rod string, often permits you to select a motor on running, instead of starting, requirements. Why not write for complete details today.

Clutches & Hydraulic Drives

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CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

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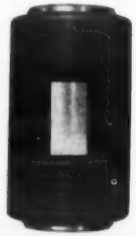
PB PIPE WIPERS

made in Tandem, Standard Single and Window types for better wiping efficiency and lower wiping costs on any rig. *Ask your PB man!*

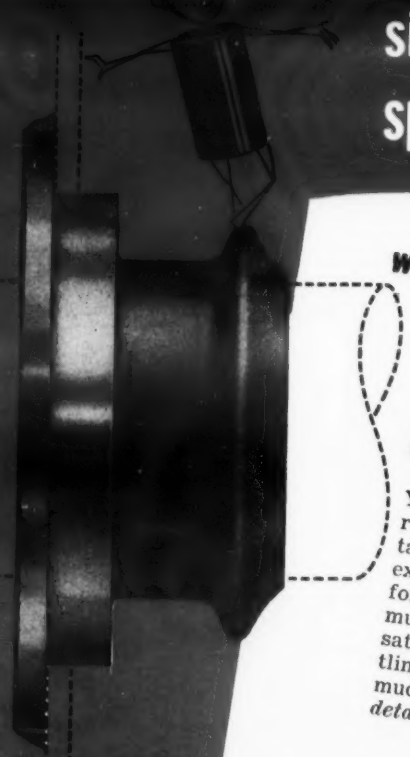


PB SUCKER ROD PROTECTORS

Protect both rods and tubing against wear, minimize the friction load, greatly improve pump efficiency, cut power costs. *Get all the facts today!*

PB WIRE LINE GUIDES

Reduce fast sheave and wire line wear by absorbing whip and lash in the wire line. For big rigs with big lines, order the Roliguide...for all ordinary work, get Rollette!



simplify mud tank installation... speed up mud line connection...

with PB FLEXLINE MUD TANK CONNECTORS

YOU NEED ONLY *plain end pipe* for connecting tanks... run your pump suction to a Flexline Connector in your tank and the Connector absorbs the pulsation. Pipe can extend as far as necessary into tank, eliminating need for accurate "spotting." Extreme flexibility allows as much as 10° misalignment without leakage. Pump pulsations and vibration are absorbed...tank or pump setting are compensated. Installation of Flexline on your mud tanks is quick, simple, inexpensive. *For complete details, consult your PB Representative listed below!*

Protection is our Business...!

PB OIL FIELD SPECIALTIES

Patterson-Ballagh

Division of Byron Jackson Co.

MAIN OFFICE: 1900 EAST 65TH STREET

LOS ANGELES 1, CALIFORNIA

PB SERVICE BRANCHES

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Ventura, Calif.	Miller 3-3964	Baton Rouge, La.	3-5933	Casper, Wyoming	972	EXPORT: Mexico City, Mexico	
Houston, Texas	WA 7196	New Iberia, La.	1420	Fairfield, Ill.	522	Buenos Aires, Argentina	

PATTERSON-BALLAGH PATTERSON-BALLAGH PATTERSON-BALLAGH PATTERSON-BALLAGH

XUM

Now ICI offers you a more efficient perforating job with Perfo-Jet because of a new port design. This new port does the work properly . . . nothing is left in the hole. You'll have no more bailing—no more fouling—no more delays in completion—no bullets, seals or gaskets left in the well. Plugging of valves or pumps after completion is eliminated.

The Perfo-Jet process has been refined and improved by development of the retained port. Working with solid aluminum ports, discharge angles, and port wall thicknesses, it was discovered THE CRITICAL VALUE WAS THE DISCHARGE ANGLE IN THE SOLID PORT. This new design is the result. Field development work proved this new port. Nothing is left in the hole. Now, Perfo-Jet, equipped with these new ports, is available to you.

You can depend on ICI to give you the finest in perforating . . . with Perfo-Jet. Be sure to call in an ICI engineer ahead of time . . . he can save you money, time, and maybe disappointment by getting you into oil-bearing formations faster, cleaner, and deeper with Perfo-Jet. You'll be sure there's nothing left in the hole.

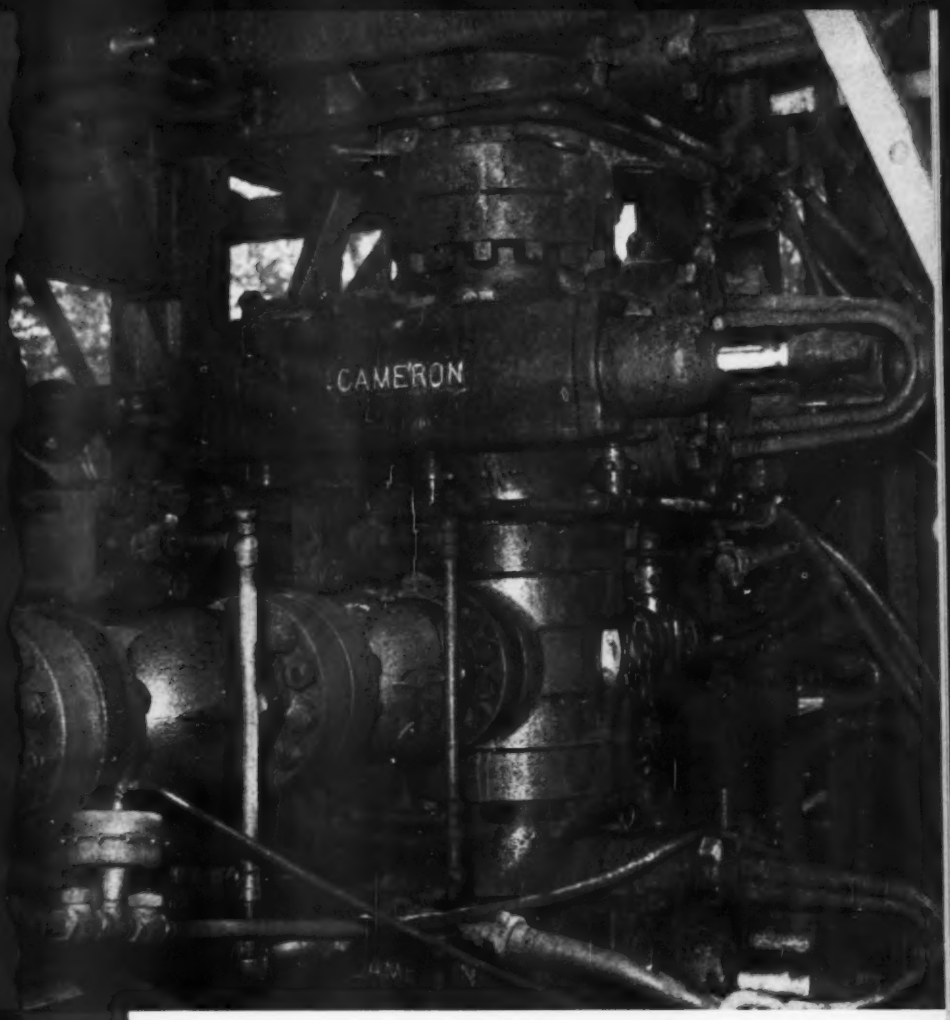
IMPROVED CHARGES. Dupont has developed a new, more efficient Perfo-Jet charge. These new charges give the same depth of penetration as charges heretofore used, but provide a 20% increase in efficiency by opening a large hole in the casing. Combine these new charges with our new port design and you've got a perforating job that can't be beat.

INTERNATIONAL CEMENTERS, INC.

Odessa, Texas, 2505 W. Second St., Telephone 9423
Casper, Wyoming, P. O. Box 866, Telephone 972

ICI Service

LOG OF A BLOWOUT THAT DIDN'T HAPPEN!



Jan. 6--
Unloaded
16 lb. mud

•

Jan. 17--
Kicked 17 lb.
mud. Rotated
through closed
rams 6 hours

•

Jan. 21--
Drilling ahead.
All's quiet.

The blowouts that **don't** happen never make the headlines. But every day, on perhaps a score or more of wells, Cameron QRC Pressure-Operated Blowout Preventer rams are closed against unruly pressures. The sticking of countless strings of drill pipe is prevented because the patented self-feeding QRC ram packing permits the operator to raise, lower and rotate his pipe through the closed rams.

With a set of Cameron QRC Pressure-Operated Blowout Preventers and HCR Flowline Valves under the derrick floor, preventing blowouts becomes a routine operation. Year in and year out since 1920, Cameron drilling control equipment has set the pace. Wherever pressure is a menace to safe drilling, nearly all wells are protected with Cameron equipment. Check your drilling operations to be sure that they are provided with this low-cost insurance.

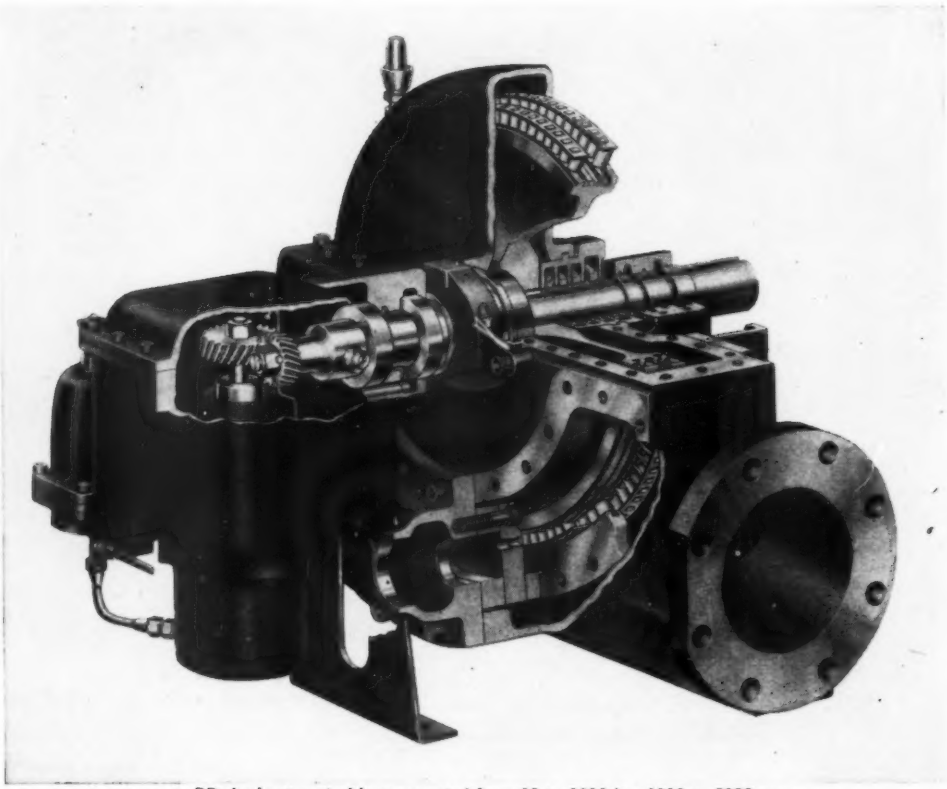
Cameron 1st *name in drilling control*

CAMERON IRON WORKS, INC.
P. O. Box 1212 Houston, Texas
Export: 74 Trinity Place, New York

Represented in the sterling area by: British Oilfield Equipment Co., Ltd., Duke's Court, 32 Duke Street, London, S. W. 1.

Now More Than Ever . . .

YOUR BEST TURBINE



DP single-stage turbines are rated from 10 to 1200 hp, 1000 to 5000 rpm

Type DP

Since the introduction of the DP turbine, more than two years ago, General Electric has been telling mechanical-drive turbine users that their best turbine buy was a *standard* design, wherever it could be properly applied. Nowadays, with the emphasis on increased output, the advantages which turbine standardization offers are even more important.

Standardization means that turbines of different rating and size have mostly identical construction features. This speeds delivery, cuts manufacturing costs, makes possible a better design and a better turbine. If you're not familiar with the General Electric DP, we suggest that you contact your nearest G-E sales office or send for a copy of bulletin GEA-4955, "A New Standard in Mechanical Drive Turbines." Write to *Apparatus Dept., General Electric Company, Schenectady, N. Y.*

GREATER RELIABILITY

From its totally enclosed governor to its durable babbitt-faced bearings, General Electric's DP turbine is built to provide greater productivity through greater reliability. Standardization has made possible "extras" such as pressure lubrication, Monel-sprayed shaft, self-positioning packings, a totally enclosed hydraulic governor. You can count on your DP for safe, dependable service in hazardous atmospheres and on tough, continuous-process assignments.

DRIVE IS A STANDARD

This DP drives a centrifugal pump in a refinery

WIDE APPLICATION FLEXIBILITY

In plants which require shifting of equipment from job to job, a standard DP frequently eliminates the need for extra drives. Because most parts are identical for all ratings, speed range and shaft horsepower can be easily and economically changed to fit new conditions. Though the DP's 30% adjustable speed range is usually adequate, a new range can be set anywhere from 800 to 5000 rpm simply by substituting a new emergency governor and governor gears. A change in horsepower rating usually requires a new nozzle plate and a few valve parts. These parts are all available on immediate delivery and save the expense of a new turbine which would be required with a less flexible, non-standard unit.

Standard spare parts kits are available with all DP turbines

EASIER, QUICKER MAINTENANCE

Because most parts of standard DP's are interchangeable on all models, spares can be easily stocked, and maintenance work handled quicker. You can have delivered with the turbine a 91-item spare parts kit, sufficient to service several machines. Socket-head cap screws are used throughout for quick disassembly. Standard shaft height, keyways, and coupling fits simplify installation. You can move DP's from job to job without change in the base structure.

GENERAL ELECTRIC

252-49

LONGER TROUBLE-FREE DRILLING

RAY-MAN ROTARY HOSE

". . . Drills more hole than any rotary hose I've seen!" • This is typical of the good word for Ray-Man Rotary Hose that's going around among tool pushers. It's no coincidence that Ray-Man lasts so long. Ray-Man is far more flexible . . . easier to transport and make up without accident. It's a self-relaxing hose that hangs steady in the rig under high pumping pressure. • Couplings are built-in, streamlined, and blow-out proof. All this adds up to less strain—less wear—more drilling per hose.

Hose, V-belts, transmission belting, packing, engineered for all phases of the oil industry, are described in Catalog 6903. A copy will be mailed to you on request.

DISTRIBUTED BY NATIONAL SUPPLY COMPANY IN ALL PRINCIPAL OIL FIELDS

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Manufacturers of Mechanical Rubber Products • Rubber Covered Equipment • Radiator Hose • Fan Belts • Brake Linings • Brake Blocks • Clutch Facings • Packings • Asbestos Textiles • Powdered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

TANNEX

gives you ALL the advantages of ordinary quebracho

PLUS

Savings in Money

Because TANNEX does not lump, cake, harden or deteriorate in storage. No losses from spoilage, no wastage from lumps settling to the bottom of the mixing barrel.

Savings in Time

Because TANNEX stays a free-flowing granular powder. Thus, no time is spent breaking it up before mixing. A uniform powder, it goes into solution quickly and takes less time to react with the caustic.

Because TANNEX is an improved quebracho compound, it gives you all the advantages of quebracho plus some of its own. TANNEX is used exactly the same as quebracho, and in the same amounts. Results? Operators who maintain careful control over their drilling muds tell us that TANNEX gives the same results as regular quebracho—sometimes even *better* results—and that TANNEX gives excellent thinning action even in the high-temperature conditions of deep-hole drilling.

500 BAROID distributors have TANNEX ready for you!

Baroid

SALES DIVISION
NATIONAL LEAD COMPANY
LOS ANGELES 12 • TULSA 3 • HOUSTON 2

COMPLETE DRILLING MUD SERVICE

One of these 27 different tubing analyses has solved practically every condition of...

- Low Carbon
- Low Carbon, ½ Mo
- Low Carbon, 1 Mo
- ½ Cr, ½ Mo
- 1 Cr, ½ Mo
- 1¼ Cr, ½ Mo
- 2 Cr, ½ Mo
- 2¼ Cr, 1 Mo
- 2½ Cr, ½ Mo, ¾ Si
- 3 Cr, ½ Mo, 1¼ Si
- 3 Cr, 1 Mo
- 5 Cr, ½ Mo
- 5 Cr, ½ Mo, 1½ Si
- 5 Cr, ½ Mo, Ti
- 6 Cr, ½ Mo
- 7 Cr, ½ Mo
- 8 Cr, 1 Mo
- 9 Cr, ½ Mo
- 9 Cr, 1 Mo
- 12 Cr, Al
- 17 Cr
- 27 Cr
- 18-8
- 18-8 Ti
- 18-8 Cb
- 18-8 Mo
- 25-20

● Here at Tubing Headquarters, we have long maintained a razor-sharp staff of specialists—men with many years of experience in solving refinery tubing problems.

These specialists have had a tremendous file of data to help them. Some of it came from our own laboratories. But the most valuable data came from actual case histories . . . and constant observation of refineries throughout the country.

To cope with numerous problems, we developed 27 different analyses that we frankly think have helped to solve almost any refinery tubing problem. We've watched these tubes in service—and we've seen them do a good job.

When you plan for future projects bring your tubing questions to National Tube Company. Most of the time, a problem that is new to you will be a simple matter of recorded history to us. All of this bed-rock experience is yours for the asking. We will be glad to help you.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(TUBING SPECIALTIES DIVISION)
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

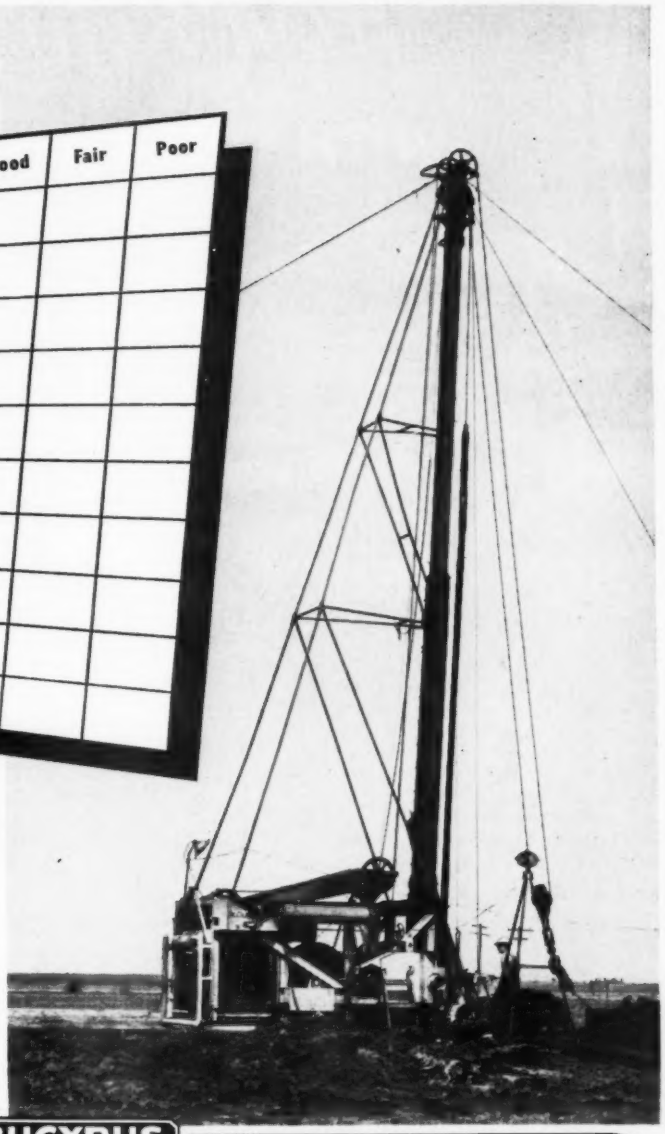
USS

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

USE THIS "SCORE CARD" TO JUDGE A SPUDDER

	Excellent	Good	Fair	Poor
Footage Output				
Mobility				
Versatility				
Rig-Up Ease				
Capacity				
Accessibility				
Control				
Rope Life				
Maintenance				
Total				



IF your spudder is a Bucyrus-Erie, you'll find it rating "tops" on *every* point, adding up to a score that means MONEY MAKING PERFORMANCE on your jobs!

FOUR GREAT MODELS:
24-L, 28-L, 36-L and 48-L

BUCYRUS-ERIE CO., South Milwaukee, Wis.

FIRST with the FINEST in Spudders

87851

See or Write Your BUCYRUS ERIE Spudder Distributor

BEACON SUPPLY CO. - - - Borger and Pampa, Texas
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DRILLING & MINING EQUIPMENT CO. - Los Angeles 21, Calif.
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LUCEY EXPORT LTD. - - Calgary and Edmonton, Alta.
THE McJUNKIN SUPPLY CO. - Charleston, W. Va.; Allen, Ky.
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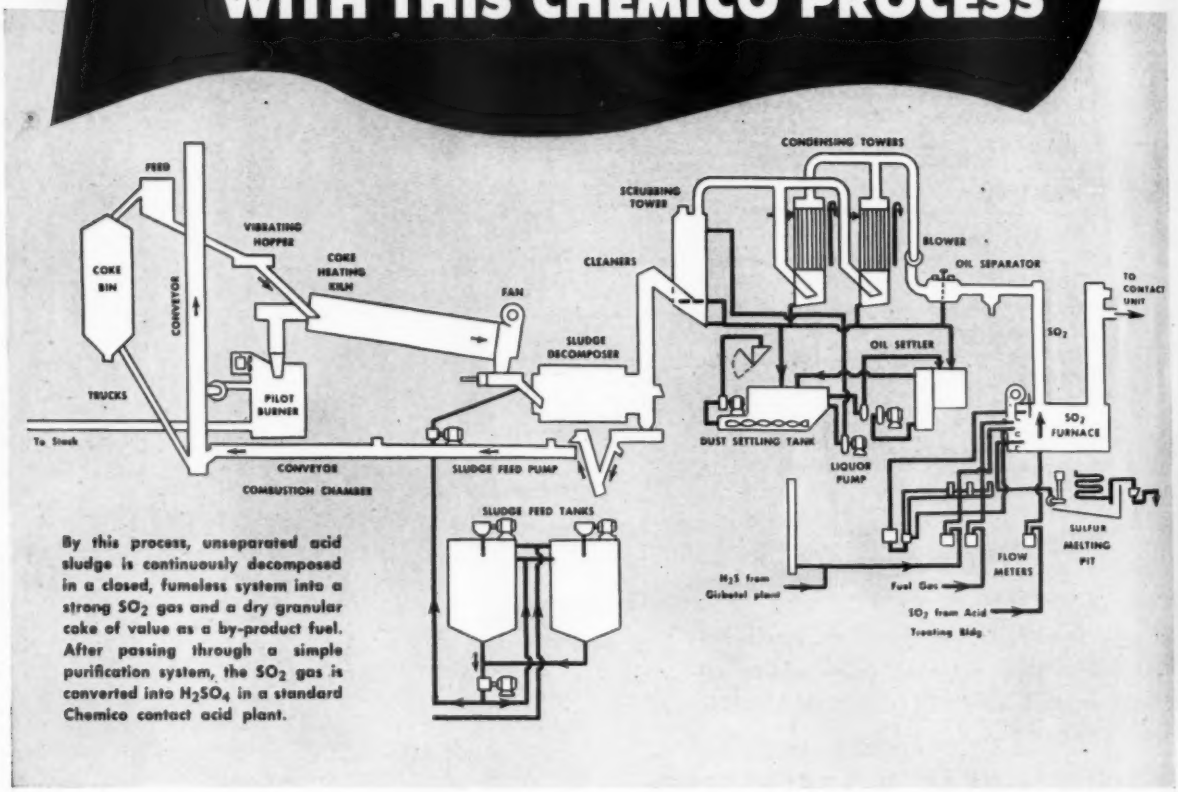
Make Sulfuric Acid from Refinery Sludge

WITH THIS CHEMICO PROCESS



By this process, unseparated acid sludge is continuously decomposed in a closed, fumeless system into a strong SO_2 gas and a dry granular coke of value as a by-product fuel. After passing through a simple purification system, the SO_2 gas is converted into H_2SO_4 in a standard Chemico contact acid plant.

With the increasing shortage of raw sulfur, industry is turning to other materials which can be used for making much-needed sulfuric acid. An important source—waste oil refinery sludge—can be converted into clean sulfuric acid of any desired strength by the Chemico process shown in the flow diagram.

This proved and practical process offers three important advantages. (1) The purified SO_2 gas provides a product acid that is free of carbon contamination. (2) The resulting H_2SO_4 may be 98% or any higher strength regardless of the initial strength of the sludge. (3) Sludges that cannot be processed by other methods may be satisfactorily used in this system.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

EUROPEAN TECHNICAL REPRESENTATIVE: CYANAMID PRODUCTS, LTD., LONDON W C. 2, ENGLAND
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Chemico plants are profitable investments

EC814

More and more pipe lines are using low-cost Purchased Electric Power in their pumping stations. Your power company is better equipped to give you better service at a lower cost than ever before! ECONOMICAL? *PEP cuts down installation, operating, maintenance, and labor costs! CONVENIENT? With *PEP you have constant, dependable service, automatic controls, a smoother and more satisfactory, trouble-free operation. Call the Power Engineer of your Utility Electric Company—he will give you complete details on *PEP.

*PEP — Purchased Electric Power

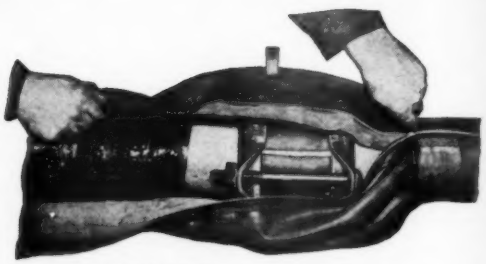
Petroleum Electric Power Association

ORGANIZED IN THE INTEREST OF GREATER SERVICE TO THE PETROLEUM INDUSTRY

CALL YOUR NEAREST ELECTRIC SERVICE COMPANY FOR MORE FACTS

Now—you simply "pull the zipper" on corrosion problems

Dresser ZIPCOAT for welded joints zips over weld area, fits closely to the pipe. 30″ lengths.



Dresser ZIPCOAT for couplings is easy to install over joint and pipe ends—all in one quick operation. Has bleeder valve to vent air during backfilling.

NEW DRESSER ZIPCOATS* GIVE SURE PROTECTION, SUPERLATIVE DIELECTRIC STRENGTH

"As easy as zipping up a jacket" is what workmen say about Dresser's new ZIPCOATS. They install ZIPCOATS in 1/10 of the time it takes to coat a joint. You get protection that equals or exceeds that offered by the mill or yard-wrapped pipe.

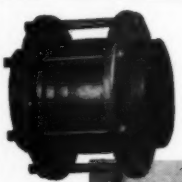
And look at the hazards you avoid: there's no flame; no heating, hauling or messy application of hot stuff; no danger from fumes or burns.

Can be installed in any weather.

Write today for descriptive material and price list.

*Every ZIPCOAT complete with anaerobic microbiological corrosion inhibitor and cold sealing compound. ZIPCOAT is a trade mark of Dresser Manufacturing Division.

Dresser ZIPCOAT for insulating joints is made like the ZIPCOAT for welds, but in ten-foot lengths. Installing one on each side of an insulating joint that's protected with a ZIPCOAT for couplings gives ultimate protection. Eliminates costly boxing and filling with dope. Immediate trench backfill saves time.



Install Dresser Insulating Couplings **IN MINUTES**

Dresser Style 39 Insulating Couplings with new plastic gaskets insulate effectively and are the simplest insulating type joint to install. Sizes ¾″ to 30″ and up.

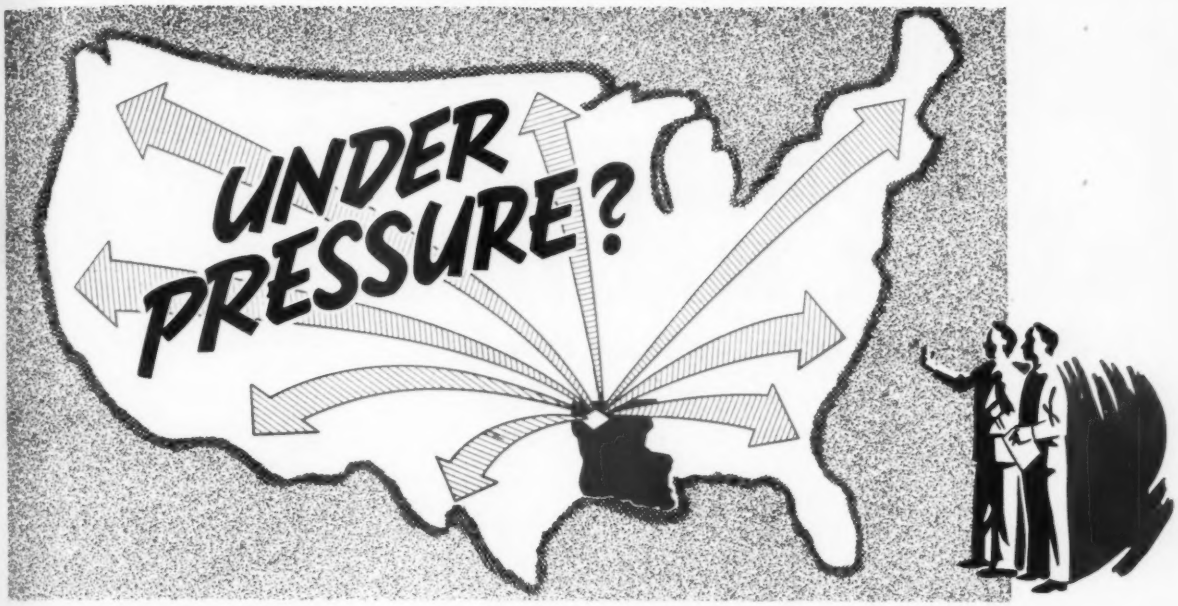
New Dresser Bonding Method saves up to 50% of cost; materials preformed

Fast bonding, giving low resistance with *pre*formed Dresser Bond and 5-second chemical welding method. Needs no special skill, no bulky equipment. Makes homogeneous weld area, eliminates surface contact variables. Compact kit of 50 *pre*formed bonds includes all materials needed for installing.

DRESSER

MANUFACTURING DIVISION

Headquarters: Bradford, Pa. (One of the Dresser Industries). Sales Offices: New York, Philadelphia, Chicago, Houston, San Francisco. In Canada: 629 Adelaide St., W., Toronto, Ontario.



SUPERIOR Can Supply You Anywhere

No matter where your oil or gas activity, *Superior* can supply you *in a hurry! Superior* covers the mid-continent oil-area with a well-balanced stock of quality supplies — nationally known brands you can depend on to do the job.

Don't let the pressure of the job slow you down. Call your nearest Superior store when you need oil and gas supplies, pipe and machinery — or expert technical advice.

Yes, SUPERIOR covers the field with a complete line of oil, gas, and industrial supplies, pipe and machinery. These supplies are as near to you as your telephone. Call your SUPERIOR store or office today!

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SUPERIOR maintains a complete machine shop and fabrication plant in Shreveport. Write for SUPERIOR'S booklet, "Save Time and Money." Learn how the "Superior Method" of prefabrication can mean efficiency and profits on piping jobs of the oil, gas, chemical and power industries.

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SUPERIOR IRON WORKS & SUPPLY COMPANY, INC.

1202-04 MARSHALL STREET • P. O. BOX 1800 • SHREVEPORT, LA.

NEW YORK CITY — TELEPHONE OREGON 9-3650

6 reasons why BLACK MAGIC is the only oil base drilling fluid you should use

It is generally conceded today that oil base muds are superior to water base muds for drilling into the producing zone. Permanent damage to the oil formation by waterblocking (Jamin action), mudding off or swelling of clay particles caused by water filtrate, has been eliminated by the use of a good oil base mud. Greater production for the entire life of the well has been the rule.

But not all oil base muds are alike. They differ in their composition and especially in the scope of their performance. Black Magic was the first successful oil base mud to be commercially available. It has had the advantage of nine years of continuous service and has set the pattern for others to follow. Only Black Magic meets all of these 6 requirements. We urge you to perform your own tests whenever possible under actual well temperature conditions and not be misled by claims that are unsubstantiated.

1 No harmful filtrates

Black Magic contains no water as such and under normal conditions can easily be maintained with a zero fluid loss. Black Magic can pick up as much as 25% water (by volume) during drilling, and still not squeeze any water into the producing formation. Black Magic will never be guilty of blocking production.

2 Excellent plastering properties

Black Magic possesses near-perfect plastering properties. It deposits a thin mud cake (1/64" approx.) which disintegrates in crude oil when the well comes on production, thus preventing any possibility of mudding off the pores of the oil zone. Holes are drilled "to gauge," too.

3 Highest return permeabilities

In every unbiased test performed on cores, Black Magic shows a greater return permeability than any other drilling mud available, sometimes recovery is as high as 96%. These experiments confirm what many operators have learned from actual drilling experience.

4 Greater flexibility

Black Magic is easy to maintain and can be weighted up to 21.4 lbs./gal. (160 lbs./cu. ft.) by adding ordinary commercial barites. It can be made lighter than water—to 7.5 lbs./gal. (56 lbs./cu. ft.) when drilling through depleted zones.

5 Lasts indefinitely

Black Magic can be used over and over again. One operator has used Black Magic continually for over a year, in a wildcat. Another is still using the Black Magic he purchased over 8 years ago. Black Magic can be regenerated easily with chemicals manufactured by Oil Base, Inc.

6 Thousands of successful jobs

Black Magic has been used in every conceivable type of well, under the most adverse conditions, yet has lived up to its promise in over 5,000 wells throughout the world. It will pay you to investigate the story of Black Magic.

Write for details and a free copy of the Black Magic Handbook.

OIL BASE, INC. MAIN OFFICE and PLANT: 130 ORIS ST., COMPTON, CALIF.

BLACK MAGIC • WHITE MAGIC • OB GEN • OB GEL • CHEMICAL "V" • CHEMICAL "X" • OB ZERO • OB MIX FIX • OB WATE • OB HEVYWATE • OB MUD GUNS • OIL BASE HAND CLEANER

XUM

XUM

Control Insulating Costs with PC FOAMGLAS

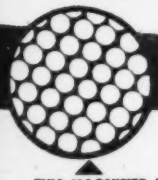
THE wide acceptance of PC Foamglas—evidenced by a long list of prominent users—is due mainly to two facts. It is an effective and economical insulation.

The cellular glass structure that makes Foamglas such an exceptionally effective insulation also makes it the long life insulation. Since glass is practically impervious to elements that destroy other materials, PC Foamglas—when properly installed—retains its original insulating effectiveness.

PC Foamglas is now available in standard flat blocks, curved segments and beveled lags, to fit equipment sides, heads and domes, and in preformed sections for standard sizes of pipe and fittings.

When you are facing special insulating problems, our specialists will be glad to consult with you. Meanwhile, you will find a lot of helpful information in our current literature. Just drop us a line and we shall be glad to send you our booklets and a sample of Foamglas. Pittsburgh Corning Corporation, 307 Fourth Avenue, Pittsburgh 22, Pa.

PC FOAMGLAS Pipe and Fitting Insulation on these hot oil feed and return lines of the Steam Electric Station of Dallas Power and Light Company, Dallas, Texas, helps maintain operating temperatures of 400°F. and 200°F. respectively. **Insulation Contractor:** Thermal Products Company, Houston, Texas.



THIS MAGNIFIED DIAGRAM SHOWS that PC Foamglas is composed almost entirely of still air, which is sealed in minute glass cells. The black areas indicate glass, the white areas air. The insulating properties of still air and the unusual resistance of glass to moisture, chemicals and other elements that cause insulation to deteriorate, make Foamglas an exceptionally effective, long lasting insulating material.

Pittsburgh Corning Corporation
Dept. DD-41, 307 Fourth Avenue
Pittsburgh 22, Pa.

Please send me without obligation, a sample of Foamglas and your FREE booklet on PC Foamglas Industrial Insulation.

Name.....

Address.....

City.....State.....

PITTSBURGH PC CORNING

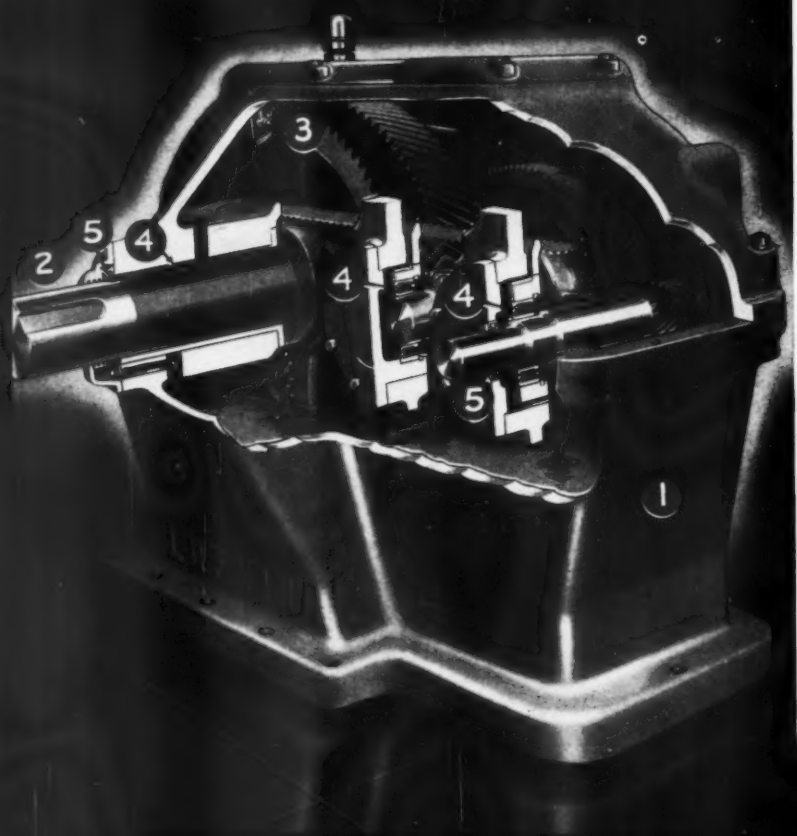
FOAMGLAS cellular glass INSULATION

... when you insulate with FOAMGLAS ... the insulation lasts!

XUM

The Lufkin Gear Box Lubrication System . . .

The heart of an oil field pumpin unit is the gear reducer. Pumpin service is generally considered t be one of the toughest application for gears. Lufkin's total output c gear reducers in this class is no over thirty thousand units. Her are the reasons Lufkin is still firs in oil field reducers:



1. The Lufkin reducer housings are of rugged construction and especially built for oil well service.

2. All shafts are forged from alloy steel which is heat treated and precision ground.

3. Gears which are precision cut on our Sykes Herringbone machines are used exclusively in Lufkin Units. These gears operate in an oil bath with gear wipers to flood the bearings.

4. Lufkin uses oversize bronzoid bearings on crankshafts and the crankshaft is held rigid by hub plates on the bearing. The pinions float on Hyatt Hy-Load Roller Bearings.

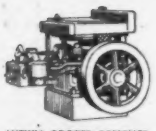
5. The pinion shaft bearings are equipped with patented oil seals, to prevent oil leaks; while the main crankshaft is equipped with collar oil slingers and annular grooved drain covers.

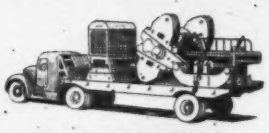
LUFKIN FOUNDRY & MACHINE COMPANY

LUFKIN, TEXAS

Branch sales and service Houston, Dallas, New York, Tulsa, Los Angeles, Seminole, Oklahoma City, Corpus Christi, Odessa, Kilgore, Wichita Falls, Casper, Wyoming, Great Bend, Kansas.
Lufkin Equipment in CANADA is handled by
THE LUFKIN MACHINE CO., LTD. 14321 108th Avenue, Edmonton, Alberta, Canada.

LUFKIN PUMPING UNITS


LUFKIN-COOPER-BESSEMER ENGINES . .


LUFKIN OIL FIELD AND INDUSTRIAL TRUCK TRAILERS

INDUSTRIAL SPEED REDUCERS AND INCREASERS

DIVISION LUFKIN FOUNDRY & MACHINE COMPANY INDUSTRIAL, MILL AND AUTOMOTIVE SUPPLIES

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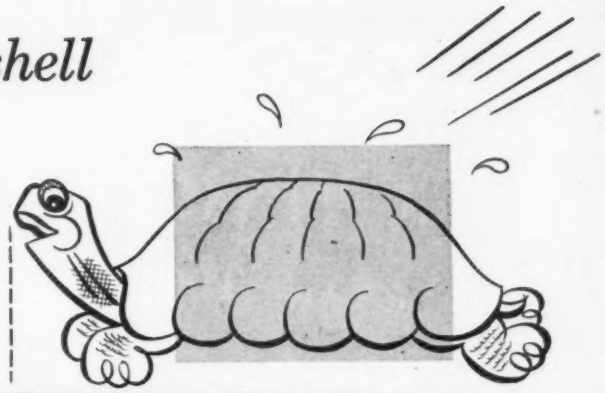
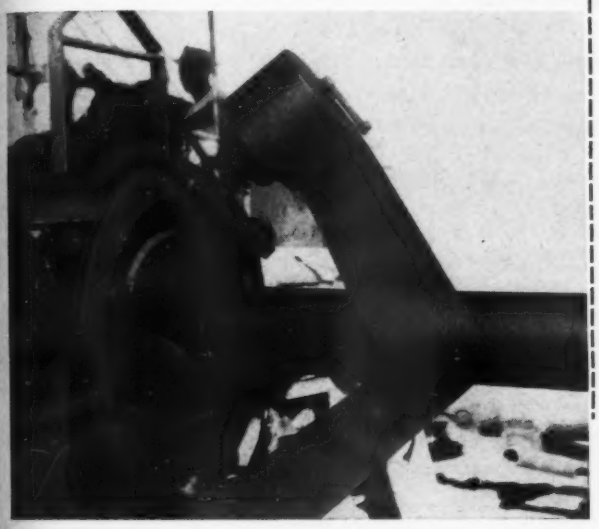
Like the turtle's tough shell that protects him so well...





Johns-Manville Asbestos Felt protects oil and gas pipe lines

Johns-Manville Asbestos Pipeline Felt now protects more than 100,000 miles of oil and gas pipe lines! *It is the only type of wrapper that has survived over 50 years of service in all types of soils.*

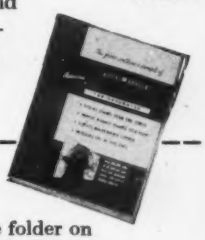
Johns-Manville Asbestos Felt is a sturdy product. It is resistant to rot and decay, and to acid and alkali soils. It has both the thickness and the toughness necessary for shielding pipe line enamels from damaging earth loads and soil stresses. These advantages make it possible for the protective enamel pipe coating to function properly against corrosion.

Johns-Manville Asbestos Felt is flexible. It wraps easily without cracking. It guards enamel from impact damage both during installation of field-wrapped pipe, and during transportation and installation of mill-wrapped pipe.

There are important economic benefits, too! Johns-Manville Asbestos Felt will help add many years to the life of the pipeline and help to keep maintenance costs low.

Johns-Manville Asbestos Pipeline Felt can be had in any width from 2" to 60", in any length desired.

For additional information and a sample of Johns-Manville Asbestos Pipeline Felt, simply fill in and mail the coupon provided below.



Johns-Manville
Asbestos
PIPELINE FELT

Johns-Manville
Box 290, New York 16, N. Y.
Please send me a copy of the sample folder on Johns-Manville Asbestos Pipeline Felt, PP-22A.

Name_____

Address_____

City_____ Zone____ State_____

Power transmission to off-shore wells with the help of...

"326" MONEL SHIELDED CABLE

Photo by Vachon, courtesy Standard Oil Company (New Jersey)

Here's the kind of cable that stands up under the severely corrosive conditions of off-shore operation... either carrying power to off-shore wells, or to bottom-hole equipment in these wells.

It's called "326"® Monel Shielded Cable.

"326" Monel—a *non-magnetic* high-Nickel alloy—has many characteristics that make it an excellent shielding material.

Like all INCO Nickel Alloys, "326" Monel is *rustproof* and highly resistant to a long list of commonly-met corrosives. Salt water and sour crudes, of course, are among them.

"326" Monel also possesses high physical properties—strength, toughness, and resistance to abrasion and mechanical damage. And it is readily brazed, soldered and welded.

Because of these characteristics "326" Monel Shielded Cable is a natural for applications where maintenance is not only costly but inconvenient.

And here's another important point. This cable is economical in price. It costs no more than other good metal-shielded cable. In some types, it actually costs *less*.

A number of well-known cable companies make "326" Monel Shielded Cable. ***But right now — with all metals in short supply because of the demands of the national rearmament and defense program — we can't promise how much will be available.***

But there are some things we *can* do. One of them is to be Johnny-on-the-spot when you run into problems involving metals for oil field use. INCO's Technical Service welcomes the opportunity to work with you. Write for their suggestions and recommendations. Naturally, this assistance is yours for the asking—no cost, no obligation involved.

EMBLEM OF SERVICE INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N.Y.

XUM

XUM

when time is money!

Drillers and production men look to

ENSIGN CARBURETION

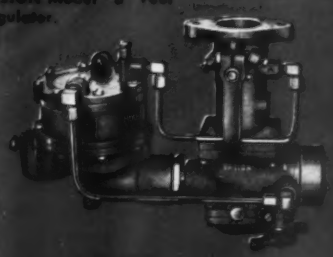
for DEPENDABLE low cost

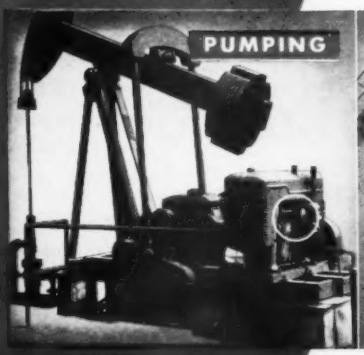
GAS ENGINE PERFORMANCE

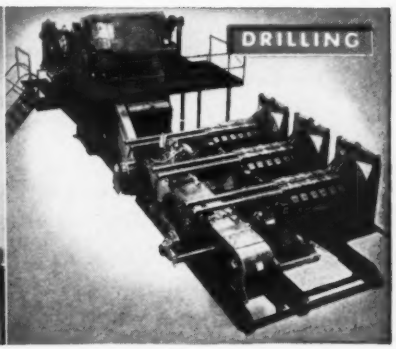
With every well drilling operation boiled down to a split second, there's little excuse nowadays for an unscheduled shut-down due to drilling engine failures. Gas engines provide DEPENDABLE and ECONOMICAL 24 hour service with the least maintenance. Good performance depends largely upon the carburetion, which in the case of over 90% of all gas engines is ENSIGN. Over 38 years of carburetor experience are designed into the simple and rugged Ensign models used on todays engines. Operators everywhere have learned to count on gas engines equipped with ENSIGN.

ENSIGN Model "Kgnl" combination Carburetor for use with Natural Gas, Butane-Propane or Gasoline.

ENSIGN Model "Kgl" Straight Gas Carburetor for either Natural Gas or Butane-Propane and ENSIGN Model "B" Fuel Regulator.







Easy to start and easy to adjust on either Natural Gas, Butane-Propane or Gasoline, ENSIGN offers a proven unit. It matters little the type of engine: Slow speed single cylinder or the high speed multi-cylinder, ENSIGN is proved and accepted the world over for the best all around performance and dependability.

ENSIGN
CARBURETOR COMPANY
Dealers and Distributors in All Principal Oil Fields

7010 SO. ALAMEDA ST., P.O. BOX 229, HUNTINGTON PARK, CALIF. • BRANCH FACTORY: 2330 W. 58TH ST., CHICAGO 36, ILLINOIS

How to give couplings a lift

Reminders of Good Casing Practice

When collar-pull elevators are used to lift casing, the bearing surface should be carefully inspected for (1) uneven wear which may produce a side lift on the coupling with danger of jumping it off, and (2) uniform distribution of the load when applied over the bearing surface of the coupling.

Reprinted by permission from "API Recommended Practice RP 5C1: Care and Use of Casing, Drill Pipe and Tubing."

MATCHED ACCURACY MAKES STRONG STRINGS

of Republic Electric Weld Casing

Uniformly accurate in size, depth, lead and taper are the threads on every joint of Republic Electric Weld Casing. Ends are gauged carefully to insure proper stand-off. Couplings are threaded with equal care and accurately matched. You get threads that spin-in and tong-up fast . . . threads that take hold with a bulldog grip.

Beneath the root line of those clean, full-formed threads is a uniform depth of sound, tough steel. Thread-cutting leaves no pull-out-inviting thin spots in *this* casing wall—it is uniformly thick and uniformly round.

Uniform wall thickness and roundness help resist external pressures, too. They combine with the high ductility steel—full normalized for uniform structure and cold sized for high yield strength—to step-up resistance to collapse.

Strong, sound threads . . . resistance to pull-out . . . resistance to collapse . . . you get them all in Republic Electric Weld Casing and Tubing.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Dept.: Chrysler Building, New York 17, New York

Republic Electric Weld Casing and Tubing are made from flat-rolled steel, both sides of which are inspected. Thus, the surface which becomes the inside wall is free from hidden defects.

REPUBLIC *Electric Weld* **NORMALIZED CASING AND TUBING**

REPUBLIC STEEL

Other Republic Products include Line Pipe—Carbon, Alloy and Stainless Steels—Upson Studs, Bolts and Nuts—Electrunite Heat Exchanger Tubes

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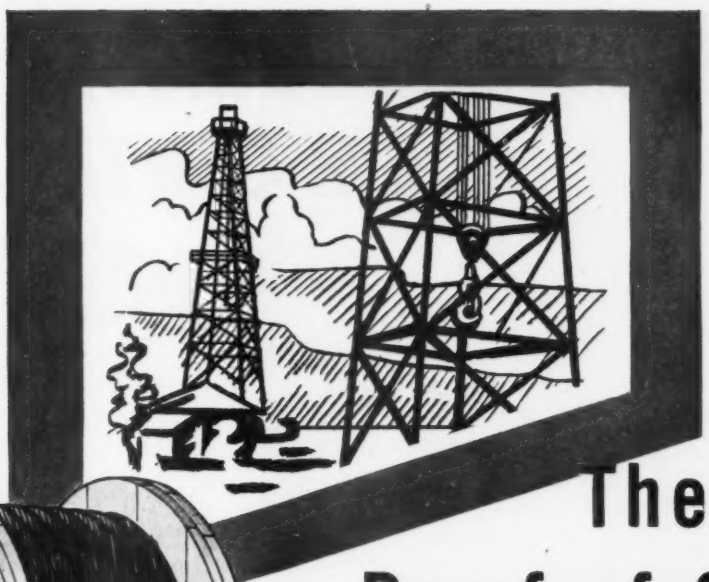

The Proof of Quality Is in PERFORMANCE

For over half a century, "HERCULES" (Red-Strand) Wire Rope has been proving its outstanding quality by the accurate yardstick of performance—on all sorts of jobs, and in one industry after another. Such *consistent* performance is not a matter of chance. Design . . . rigid tests and inspections . . . equipment . . . firm standards — are essential factors.

As "HERCULES" is made in a wide range of sizes, types and constructions—Preformed or Non-Preformed—there is in this one grade, a "right rope" for *any* heavy duty purpose.

We Invite Your Inquiries

MADE ONLY BY

A. LESCHEN & SONS ROPE CO. **5909 KENNERLY AVE. • ST. LOUIS 12, MO.**

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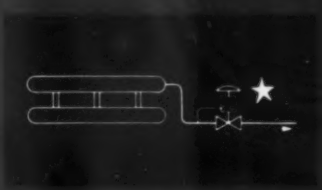
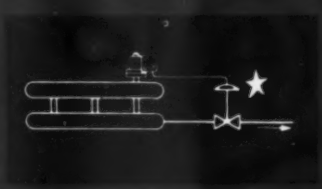
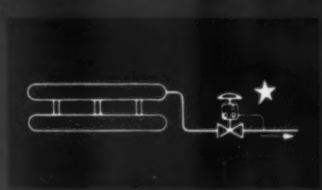
. . . the INDUSTRY'S MOST VERSATILE DIAPHRAGM CONTROL VALVE



SACK PRESSURE VALVE



SEPARATOR OIL VALVE



REDUCING VALVE

PRESSURE INTERMITTER

HI-LOW SAFETY VALVE

TIME CYCLE INTERMITTER

FISHER GOVERNOR CO.

FISHER® TYPE 57T-D

Fisher Type 57T-D is available in 3000 lbs. and 6000 lbs., globe or angle, cast steel bodies. Globe body sizes ½" through 2"; angle body sizes 1" and 2". Furnished with *Fisher Teflon V-Ring Packing* that requires no lubrication.

Write for complete information on Fisher Wizard Pilot and Time Cycle Intermitter.

MARSHALLTOWN, IOWA

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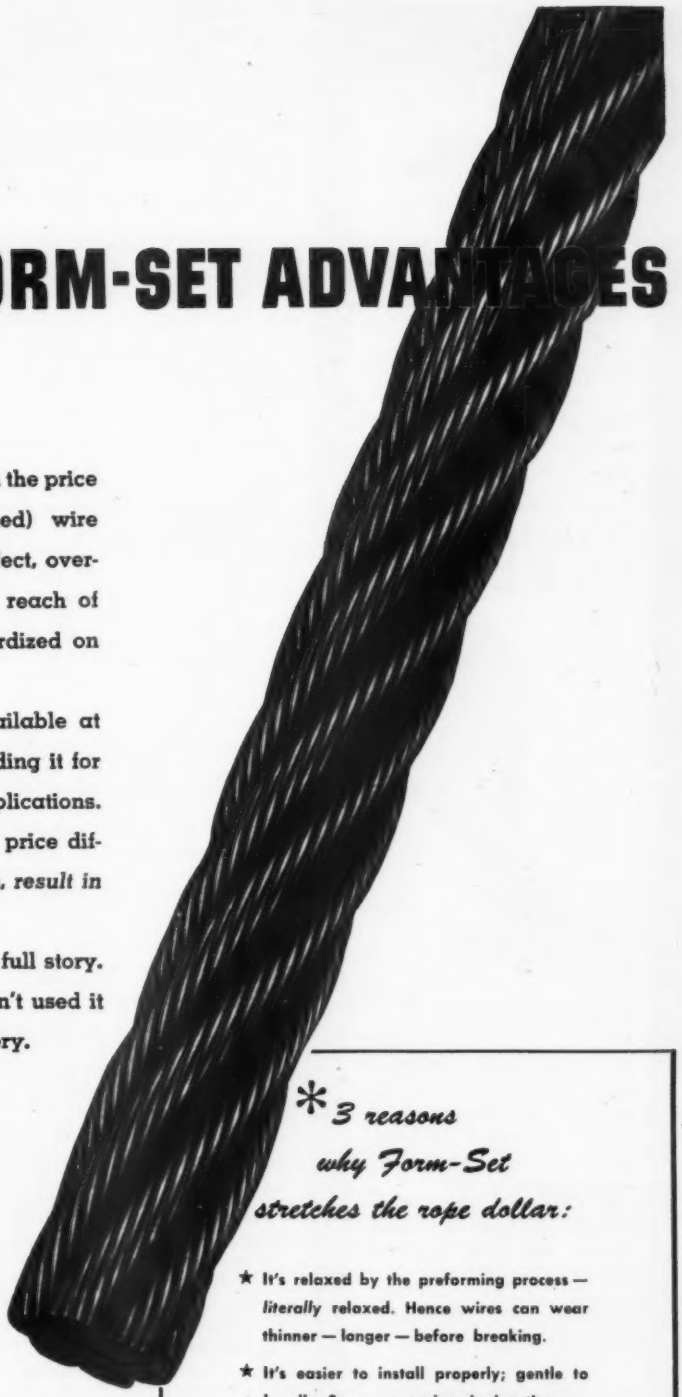
You pay so little more

for these EXTRA FORM-SET ADVANTAGES

Some time ago we announced a big cut in the price differential between Form-Set (preformed) wire rope and the non-preformed type. The effect, overnight, was to bring Form-Set within the reach of many users who had previously standardized on non-preformed.

Since Bethlehem Form-Set is now available at such slight extra cost, we are recommending it for practically *all* hoisting and operating applications. Its advantages not only offset the minor price difference . . . they actually, in many cases, *result in substantial wire-rope economies.**

Ask a Bethlehem man to give you the full story. Then try a reel of Form-Set. If you haven't used it before, you're due for a welcome discovery.



Bethlehem Form-Set wire rope after cutting. Note that preforming eliminates the need for seizing.

*3 reasons why Form-Set stretches the rope dollar:

★ It's relaxed by the preforming process — *literally* relaxed. Hence wires can wear thinner — longer — before breaking.

★ It's easier to install properly; gentle to handle. Saves expensive rigging time.

★ It's highly resistant to kinking. And, because spooling is tighter, more uniform, there's less crushing and distortion.

BETHLEHEM WIRE ROPE
BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Scottie "Daring Young Man" McBlock swings through the air with the greatest of ease.

McKISSICK
SAFETY FLOOR
BLOCK

SWAYS laterally WITH EASE

...when used with swivel stand and patented adaptor. Sheave groove and wire line are always in conformity on wire line spools from winch drum.

All steel construction, alloy flame hardened sheaves grooved to line size.

Hi-Load roller bearings, Alemite Lubrication.

Write for information on this and other McKissick Products.

McKISSICK BUILDS A BETTER BLOCK FOR EVERY PURPOSE

McKISSICK

McKISSICK PRODUCTS CORPORATION
Box 2496 Tulsa, Oklahoma

They Say—

Controls Peril Cited

". . . The various agencies of Government must . . . be guided by an understanding of the requirements of a dynamic expanding economy. No action should be taken which will decrease the efficiency and productivity which is the cornerstone of our national strength. Controls inevitably result in such decreases.

Industry must be able to remain solvent to generate capital for growth. Only by growth—growth in facilities and in technological efficiency—can our economy meet coming military and civilian needs. Productivity is the key to our national survival; therefore, productivity, not control for its own sake, must be the watchword.

"The oil industry in particular has an enormous job in front of it. The industry's record in World War II is proof that it will strain every effort to meet the requirements of war preparedness. This experience also demonstrates that the industry functions best when competition is preserved as the stimulus for ingenuity and resourcefulness.

"With grave appreciation of the task ahead and a most serious sense of what failure would mean, Sun Oil Co. is dedicated to meet to the utmost of its ability every requirement placed upon it for national security and to maximize its contribution to the defense of freedom and essential human liberty."

—Statement of the board of directors, Sun Oil Co.

"Government control of one segment of our economy would lead to the control of our entire economic system. The result of end-use control of energy resources is economic regimentation of industry, a reduction of our standard of living, and a forfeiture of world industrial and cultural leadership.

"This would mean a severe weakening of our national defenses against both ideologies and military might of aggressor nations."

Charles E. Simons, Dallas, vice president and general manager, Texas Mid-Continent Oil and Gas Association, at District Committee Meeting of O.I.I.C., Kansas City.

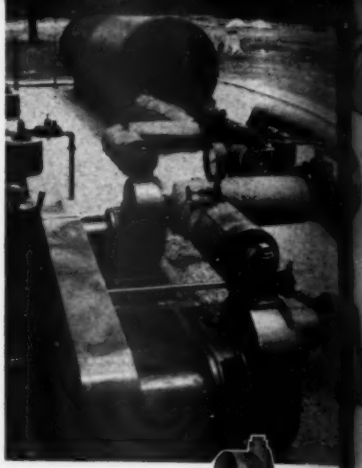
What Oil People Did Last Year

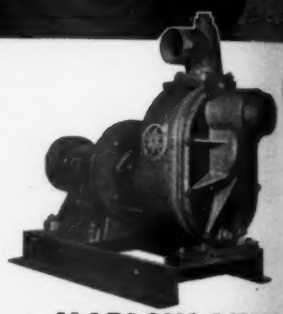
"What did the oil industry do last year?

"From the standpoint of you, as an individual, it kept on supplying the gasoline and fuel oil and any and all other oil products that you wanted.

"Looking at the larger picture, the

NO TROUBLE
PERMITTED HER





...so MARLOW PUMPS
are put to work.

Efficient, trouble-free pumps MUST be used on the important oil country service of circulating hot water for an indirect emulsion heater. Temperatures of the treating tank must be kept uniform by a constant hot water flow. That's where Marlows come in.

The two Marlow Model 34EB Self-Priming Centrifugal pumps above are used by Continental Oil Company at Ville Platte, Louisiana, to handle this critical operation. It is one of four such crude oil emulsion heater systems on Continental leases in the Ville Platte area — AND MARLOW PUMPS ARE USED ON THEM ALL.

Marlow Pumps are ideal for many oil country jobs. Write for complete information.

MARLOW PUMPS
544 GREENWOOD AVENUE
RIDGEWOOD, NEW JERSEY
Engineers and Representatives Everywhere

XUM

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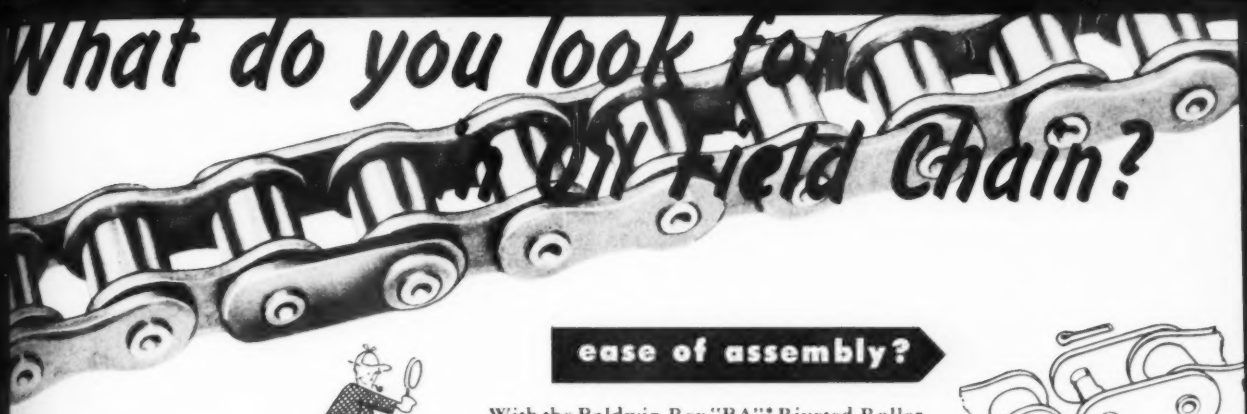
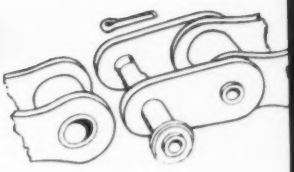
What do you look for in an Oil Field Chain?



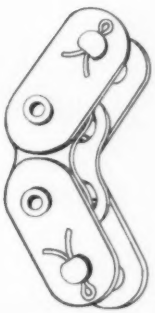
ease of assembly?

With the Baldwin-Rex "BA"* Riveted Roller Chain, assembling or disassembling roller chain in the field or in the supply store is the easiest you've ever known. Just locate the special connector link, remove the cotter and drive out the pin. That's all there is to it. No danger of damaging parts or fits as with ordinary riveted chain.



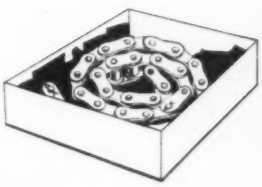
ease of adjustment and repair?

Keep a supply of "BA" 3 Pitch repair units on hand. They're your insurance against loss of drilling time. If a chain becomes damaged while in service, it can quickly be fixed right on the job by inserting one or more repair units. What's more, "BA" repair units are interchangeable with any standard roller chain.

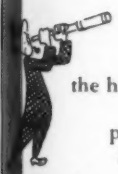


fast, convenient service?

The "BA" Assembly is shipped in boxes containing two standard 5-foot lengths of chain. Each strand contains two single pin connectors at approximately the 2′ and 5′ mark. Thus, it's easy for you or your supply store to *build up* exact length of chain you need without "cutting" chain. Standard "BA" short units of various lengths are available for this purpose. Offset links can also be added and then removed to compensate for chain elongation.



high strength and ability to "take-it"?



All Baldwin-Rex Roller Chain is made of the finest material, manufactured to the highest quality standards. With "BA" you get all the advantages of riveted chain—long life . . . high strength . . . a more positive lock between pin and plates—plus the amazing ease and convenience of handling described above. What's more, in single strand, the cost of "BA" is actually lower than the cost of cottered chain!

*"BA" means Baldwin Assembly

So next time you order chain, be sure to "look for" the distinctive "BA" link. It's the sign of quality, convenience, service and economy.

For all the details on all Rex and Baldwin-Rex Oil Field Chains, write for bulletin 51-8. Chain Belt Company 1619 West Bruce Street, Milwaukee 4, Wisconsin

BALDWIN·REX®
ROLLER CHAINS

BALDWIN-DUCKWORTH DIVISION OF CHAIN BELT COMPANY

"MADE TO ORDER"

for Oil Field Drilling

REX® A.P.I. CHAINS

These famous rotary drilling chains are especially built for oil field needs. Five Rex features make them perennial favorites around the drilling rigs.

★ **BALANCED DESIGN**—strength of chain parts is properly balanced for longer life . . . lighter weight.

★ **MAXIMUM WEAR RESISTANCE**—high carbon alloy steel, heat treating, case hardening, all combine to produce a chain that lasts longer.

★ **FORCE FIT ASSEMBLY**—parts machine assembled into famous Rex Unit Link. Each link exactly alike—they retain uniformity under toughest conditions.

★ **EFFECTIVE LUBRICATION**—oil holes in bushings assure placing of oil where it's really needed.

★ **EASY TO TAKE APART**—Rex 3-diameter pin makes assembly and disassembly easy. No need for heavy driving or use of drift pins.

NO OTHER PUMP COMBINES ALL THESE!

The Rex Self-priming Oil Field Utility Pump combines 5 great features that add up to *outstanding performance—outstanding value.*

★ Extremely Simple Design.

★ All Wearing and Moving Parts accessible with removal of one cover plate.

★ Lightweight...easily portable, yet really sturdy.

★ Simplest, most positive leakproof seal ever designed.

★ Patented Rex Adjustable Air Peeler assures "new pump" efficiency for its entire life.

See it at your nearest supply store. Rex Oil Field Sales Offices are located in these cities:
NEW YORK • TULSA • DALLAS • HOUSTON
MIDLAND • LOS ANGELES

CHAIN BELT COMPANY

BALDWIN-DUCKWORTH DIVISION
SPRINGFIELD 2, MASS.

REX CHAIN & TRANSMISSION DIVISION
MILWAUKEE 4, WIS.

REX CONSTRUCTION MACHINERY DIVISION
MILWAUKEE 4, WIS.

people who constitute the American oil industry did a number of things of the highest importance in 1950.

"They drilled the greatest number of wells in history, and boosted refinery capacity to an all-time peak. They processed more crude oil than ever before, and at the same time increased the nation's proved reserves. They plowed back some $3,000,000 of their earnings in capital investment and spend $100,000,000 on research which will make possible more and better oil products in the future. The American people displayed an appetite for 271,000,000 gal. of oil products every 24 hours, and the oil people saw that they got it.

"If anybody thinks that free enterprise is a dead letter in the modern world and that we have entered some sort of a new era in which the Government should do everything, run everything, control everything, and own everything, oil's record is a mighty good answer. Oil isn't operated by politicians. It doesn't beg Congress for appropriations. It just goes ahead meeting our gigantic current demand, and preparing for the coming year."

—*Editorial in the Natchez (Miss.) Times.*

CALENDAR

April

Brussels International Fair, twenty-fifth annual event, Brussels, Belgium, April 21-May 6.

American Gas Association, industrial and commercial gas section, industrial gas school, William Penn Hotel, Pittsburgh, April 29-May 4.

American Geophysical Union, thirty-second annual meeting, National Academy of Sciences, Washington, D. C., April 30-May 2.

American Petroleum Institute, Division of Refining, sixteenth midyear meeting, Mayo Hotel, Tulsa, April 30-May 3.

Materials Handling Conference, International Amphitheatre, Chicago, April 30-May 4.

May

American Oil Chemists' Society, spring meeting, Roosevelt Hotel, New Orleans, May 1-3.

American Institute of Electrical Engineers, District 1 meeting, Hotel Syracuse, Syracuse, N. Y., May 2-4.

Fuel Oil Distributors Association of New Jersey, annual convention, Berkeley-Carteret Hotel, Asbury Park, N. J., May 3-4.

Pennsylvania Petroleum Association, Inc., annual spring convention, Bedford Springs Hotel, Bedford, Pa., May 6-8.

New York Oil Heating Association, Inc., Hotel Statler, New York, May 7.

American Gas Association, Natural-Gas Department, Dallas, May 7-8.

Independent Petroleum Association of America, midyear directors' meeting, Cosmopolitan Hotel, Denver, May 7-8.

Gas Appliance Manufacturers Association, natural-gas department spring meeting, Dallas, May 7-9.

Liquefied Petroleum Gas Association, annual convention and trade show, Stevens Hotel, Chicago, May 7-10.

American Petroleum Institute, Division of Production, Pacific Coast district, spring meeting, Biltmore Hotel, Los Angeles, May 10-11.

Pennsylvanian Geology and Mineral Resources of Western Indiana, fifth annual field conference, sponsored by division of

best for the job

• SELF PRIMING
• CENTRIFUGAL

McGOWAN PUMPS

These rugged McGOWAN all welded steel pumps are lighter, yet stronger, more durable than any you've ever seen. Now in operation in Oil Fields throughout the world. They feature — automatic priming • non-clogging impeller hardened wear plates • large access plates • tested and trouble free shaft seals.

SINCE 1852 McGOWAN PUMPS

Long life service means extra economy! McGowan Pumps have been serving the Industry since 1852. See your Supply Co. or write today for catalog sheets, complete information.

McGOWAN PUMP DIV., Leyman Mfg. Corp.
58 Central Ave., Cincinnati 2, Ohio
Please send without obligation data on McGowan self priming centrifugal pumps.

COMPANY_____

NAME_____

ADDRESS_____

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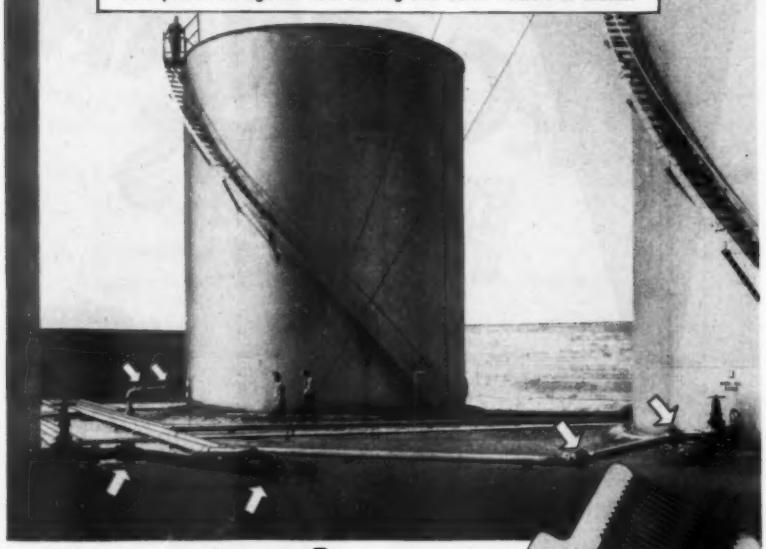
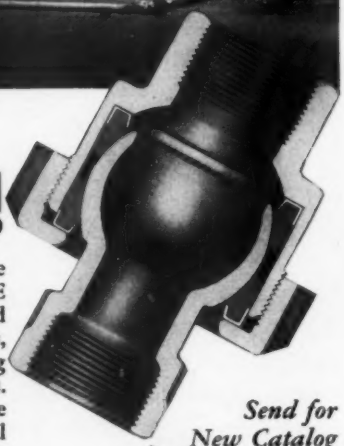
How Would You Solve THIS PIPING PROBLEM?

THIS PICTURE shows how a typical piping problem is solved easily and economically with BARCO FLEXIBLE BALL JOINTS. The tanks at this West Coast river terminal are irregularly spaced on rolling ground at various elevations. Connecting them with rigid piping would have required careful surveying, pipe cutting, and figuring of angles. With Barco Joints, careful measurement and alignment is unnecessary. These fireproof, flexible connections also provide valuable protection against tank settling and earth tremors or shocks.



Here's the ANSWER!



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geology, Indiana Department of Conservation, and department of geology, Indiana University, Bloomington, Ind., May 11-13.

American Institute of Chemical Engineers, regional meeting, Hotel Muehlebach, Kansas City, May 13-16.

American Gas Association, operating section, production and chemical conference, Hotel New Yorker, New York City, May 14-16.

Pennsylvania Gas Association, Wernersville, Pa., May 15-17.

Pacific Coast Gas Association, annual transmission (technical) conference, Bakersfield, Calif., May 16-17.

American Institute of Electrical Engineers, District 5 meeting, Loraine Hotel, Madison, Wis., May 17-19.

Empire State Petroleum Association, Inc., Hotel Statler, Buffalo, N. Y., May 20-22.

American Petroleum Institute, conference on products-pipe-line technology, Biltmore Hotel, Atlanta, May 21-23.

Intermountain Association of Petroleum Geologists, second annual field conference, Canyon, House, and Confusion range areas of Millard County, Utah; headquarters, Forrest Hotel, Nephi, Utah; May 23-26.

Second annual John Zink Process Heating Seminar, John Zink Co., 4401 South Peoria, Avenue, Tulsa, May 26.

American Petroleum Institute, Division of Marketing, midyear meeting, Cincinnati, May 28-29.

Third World Petroleum Congress, Kurhaus, Scheveningen, the Netherlands, May 28-June 6.

American Petroleum Institute, standardization and standing committees, Division of Production, midyear meeting, Brown Palace Hotel, Denver, May 28-June 1.

Institution of Gas Engineers, London, England, May 29-June 1.

Natural Gas and Petroleum Association of Canada, Royal Connaught Hotel, Hamilton, Ont., May 31-June 1.

June

Society of Automotive Engineers, Inc., summer meeting, French Lick Springs Hotel, French Lick, Ind., June 3-8.

New York Oil Heating Association, Inc., Hotel Statler, New York, June 4.

National Oil Scouts and Landmen's Association, annual convention, Hotel Beaumont, Beaumont, Tex., June 7-9.

Rocky Mountain Oil and Gas Association, midyear meeting, Henning Hotel, Casper, Wyo., June 8-9.

Liquefied Petroleum Gas Association, Inc., first annual Mountain States district convention and trade show, Troutdale-in-the-Pines, Evergreen, Colo., June 10-12.

American Society of Mechanical Engineers, semiannual meeting, Toronto, Ont., Canada, June 11-15.

Pennsylvania Grade Crude Oil Association, 1951 annual meeting, Hotel William Penn, Pittsburgh, June 14-15.

Canadian Gas Association, Bigwin Inn, Lake of Bays, Ont., Canada, June 16-20.

Petroleum Equipment Suppliers Association, annual meeting, Chateau Frontenac, Quebec, Canada, June 17-20.

American Society for Testing Materials, annual meeting, Atlantic City, N. J., June 18-22.

Kentucky Oil and Gas Association, annual meeting, Ventura and Henry Clay hotels, Ashland, Ky., June 21-22.

American Institute of Electrical Engineers, summer general meeting, Royal York Hotel, Toronto, June 25-29.

July

Wyoming Geological Association, sixth annual field conference, Rawlins, Wyo., July 31-August 3.

August

Society of Automotive Engineers, Inc., West Coast meeting, Olympic Hotel, Seattle, August 13-15.

American Institute of Electrical Engineers, Pacific general meeting, Multnomah Hotel, Portland, Ore., August 20-23.

September

American Chemical Society, 120th national

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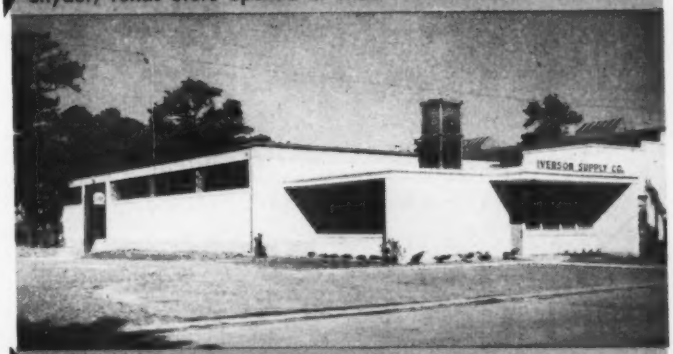
Borger, Texas opened in 1926

Farmington, New Mexico Store opened in 1950

Snyder, Texas Store opened in 1950



Houston, Texas Store opened in 1950

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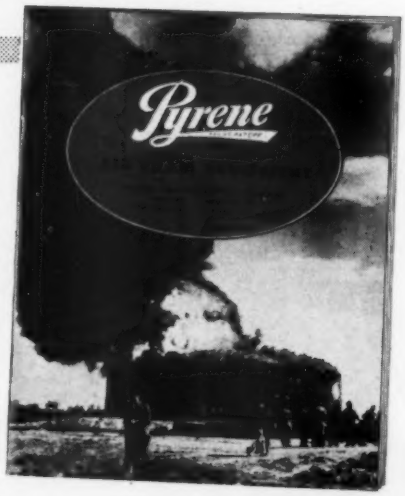

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Diamond Jubilee meeting, Hotel Statler, New York City, September 3-7.

Pacific Coast Gas Association, annual convention, Fairmont Hotel, San Francisco, September 4-6.

Michigan Petroleum Association, annual fall convention, Ramona Park Hotel, Harbor Springs, Mich., September 6-7.

International Union of Pure and Applied Chemistry, sixteenth conference, Hotel Statler, New York City, September 8-9.

New York Oil Heating Association, Inc., Hotel Statler, New York City, September 10.

International Congress of Pure and Applied Chemistry, twelfth conference, Hotel Statler, New York City, September 10-13.

Instrument Society of America, Coliseum, Houston, September 10-14.

American Society of Mechanical Engineers, Industrial Instrument and Regulators division, Coliseum, Houston, September 10-14.

National Petroleum Association, Hotel Traymore, Atlantic City, September 12-14.

International Union of Pure and Applied Chemistry, sixteenth conference, Hotel Statler, Washington, D. C., September 14-15.

American Association of Oilwell Drilling Contractors, eleventh annual meeting, Texas Hotel, Fort Worth, September 21-23.

American Society of Mechanical Engineers, sixth petroleum mechanical-engineering conference, Mayo Hotel, Tulsa, September 24-26.

American Society of Mechanical Engineers, fall meeting, Radisson Hotel, Minneapolis, September 25-28.

October

California Natural Gasoline Association, twenty-sixth annual fall meeting, Ambassador Hotel, Los Angeles, October 4-5.

Texas Mid-Continent Oil and Gas Association, annual meeting, Hotel Beaumont, Beaumont, Tex., October 8-9.

American Oil Chemists' Society, fall meeting, Edgewater Beach Hotel, Chicago, October 8-10.

National Safety Council, thirty-ninth national safety congress and exposition, Stevens Hotel, Chicago, October 8-12.

Indiana Independent Petroleum Association, fall convention, Hotel Severin, Indianapolis, October 13-14.

Oil Progress Week, October 14-20.

American Petroleum Credit Association, twenty-seventh annual conference, Adolphus Hotel, Dallas, October 15-17.

American Gas Association, annual convention, Kiel Auditorium, St. Louis, October 15-17.

National Metal Congress and Exposition. American Society for Metals, American Welding Society, American Institute of Mining and Metallurgical Engineers, and Society for Non-Destructive Testing, Hotels Statler, Book-Cadillac, and Detroit-Leland, Detroit, October 15-19.

American Institute of Mining and Metallurgical Engineers, petroleum branch, fall meeting, Houston, October 20-22.

Independent Petroleum Association of America, Shamrock Hotel, Houston, October 21-23.

American Institute of Electrical Engineers, fall general meeting, Hotel Cleveland, Cleveland, October 22-26.

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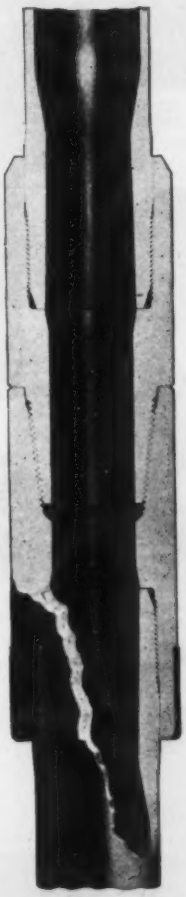

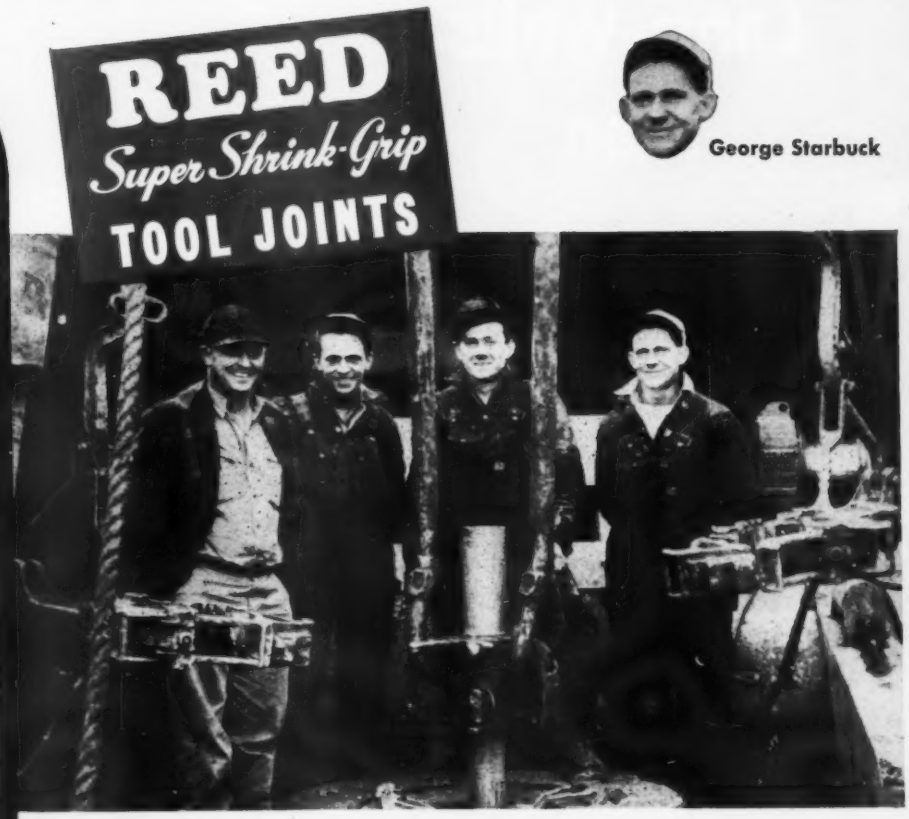

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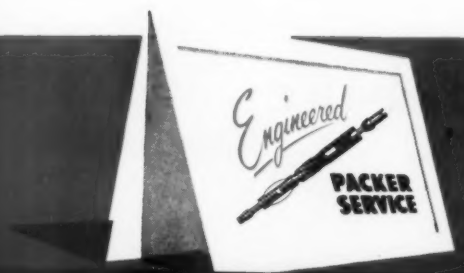

...by...

LANE WELLS

TECHNICAL OILFIELD SERVICES

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JOURNALLY Speaking

No Rustling Steel

WHAT with the shortage of steel and the high price of scrap iron, it's getting so an oil operator dassn't turn his back on a piece of equipment unless it's nailed down at both ends. Even a derrick left unwatched is liable to be cut up into No. 1 melting scrap over a week end.

But down Texas way the oilfield thieves had better watch out. The Texas Mid-Continent Oil and Gas Association set up a crook-catching department which includes an ex-sheriff and military police investigator. So, podner, better go slow about throwing your brand on any maverick tubular goods. Getting your stuff on Form PAD-17 may be slower but it's a lot healthier.

Sixth Sense

DO the geological sciences really have all the answers to the problem of finding oil, or is there something beyond the ken of natural science, some sort of sixth sense?

In St. Louis this week several hundred professional oil finders are eruditely exchanging tips on their trade, and anyone scanning the program would conclude that these men have mustered all branches of science to their command. Nevertheless, some wildcats find oil and others don't—a fact which may cause laymen to wonder if finding oil isn't more of an art or a gift than a science.

Belief in the occult seems utterly fantastic in this day and age, yet this belief has persisted in some quarters since the first oil well was drilled. Within the past couple of months we have run into two men who claim to have within themselves some mysterious power to locate oil buried in hidden containers or in undiscovered stratigraphic traps. Neither one can—or will—explain his method, but each claims he can take up where the scientists leave off and can pinpoint the location for a wildcat after the exploration department has gone as far as it can go.

Such men seem completely sincere, and they can't understand why big oil companies don't snap them up. The explanation is that doodlebugs and supernatural oil-finding methods have a long and sad record of failure. The likelihood of their success dims with each advance in factual knowledge of the occurrence of oil, and the willingness to risk huge sums in testing them decreases with every advance in the cost of wildcatting.

But there is a sort of sixth sense which oil companies will spend big money to get. It may be beyond the realm of exact science, but it isn't an occult manifestation. It is a human, though perhaps inexplicable, ability to make a shrewd scientific guess plus a generous portion of plain, old-fashioned good luck.

Sign Language

ONE of the lesser-known projects of the United Nations, and one which so far has not been vetoed by the Soviets, is international standardization of highway signs. The idea is to adopt a series of pictures and symbols which can be understood by any motorist regardless of what language he speaks. This should be appreciated by any American who has driven abroad and been confused by the foreign-language signs encountered. If it works other places we suggest it be tried in this country, where many presumably English-speaking drivers don't seem to be able to understand the meaning of a sign bearing the simple word STOP.

Spell of the Yukon

THE capital of Canada's Yukon Territory is being moved from Dawson, once famous for the Shooting of Dan McGrew, to Whitehorse, once famous as the site of the refinery for the Army's oil fiasco known as the Canol Project. Though the refinery was moved away as soon as peace and sanity demonstrated the futility of Canol, the Alaska highway remains to bring the blessings of the motor age to Whitehorse and enable it to outstrip the isolated Dawson as the center of activity in the Klondike region. Thus normal economic development brings to Whitehorse a prosperity more stable than that promised by government planning—which should be a lesson to it and some others.

Henry D. Ralph

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April 26, 1951

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"First" and ONLY "Whirling" Action

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This is Product No. 101 M&F—Baker Cement Float Collar—usually positioned just above the shoe joint to provide a "stop" for the cementing plug. Used in combination with any type of Baker Cement Shoe selected to meet customer's specifications.

Brings "LASTING" Results

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How to Find Oil

Geology and the other sciences which have been employed in the study of the earth's crust during the past generation have made tremendous strides in understanding the occurrence of oil in the ground. The new tools which have been added to the explorationist's kit and the accumulation of knowledge which they have provided have done much to increase the success ratio in wildcatting.

It is true that neither the venerable science of geology nor the new sciences of electronics and nuclear radiation have produced a push-button oil finder or a magic formula, and this has led many people to wish for some new oil-finding tool. Certainly, the search for new methods should continue, but meanwhile present tools must be fully utilized.

In the present state of our knowledge, the business of finding oil is as much an art as it is a science. The art lies in the skill and imagination with which the data developed by all available means are correlated and interpreted. Oil has been found in areas condemned by one or several of the usual methods of selecting likely prospects, and this embarrassing fact would seem to indicate that too much reliance was put on the tool itself and not enough in the art of using it.

Each new tool that has come along—the gravity meter, seismograph, core analysis, well logging—has widened the body of knowledge, but in the same proportion it has increased the degree of skill needed in interpreting and applying this knowledge.

Like the farmer who refused to buy a book on better farming because he wasn't farming as well as he knew how already, perhaps the exploration industry needs a new tool less than it needs better application of its present tools. Such, at least, is the belief of some of our leading geologists, who admonish their fellows to use more imagination in correlating the data obtained from all presently known exploratory methods and devices.

Unless and until some foolproof oil finder is invented, the industry must depend on the drill as the only sure test. But behind the drill there must be that thing called management. Good management is as hard to define as oil is hard to find, but it includes a shrewd assaying of all available facts, plus an accumulation of capital, plus willingness to risk that capital.

So here is the recipe for finding oil: Take equal portions of the data obtainable from all known sciences and instruments, correlate them thoroughly, and mix with liberal portions of imagination. When this mixture has thoroughly jelled, strain through shrewd management capable of making bold decisions, add large quantities of risk capital, and pour the whole into a wildcat for the proof of the pudding.

No one of these ingredients should be left out. If new exploration tools come along, they will supplement but not supplant the best tool of all—imagination and venture at the top end of a drill string.

XUM

THIS WEEK

DRILLING—Use of quebracho for drilling operations cut sharply by NPA. . . . Drilling companies told they will have to resort to substitutes. . . . Order designed to conserve vegetable tanning materials. . . . ¶California operators planning 150 more wells in second quarter than in same period last year. . . . ¶June steel allocation provides for drilling at rate of 43,000 wells per year. . . . ¶Contract prices and fees of drilling contractors removed from price control by OPS. . . .

MATERIALS—Key men in Government warned that oil-for-defense program will bog down if steel is lacking at any point from exploration to service station. . . . June tubular-goods steel allocation set at 140,000 tons. . . .

PRODUCTION—New world record set during February with average daily output of 11,382,000 bbl. . . . Venezuela, United States, Middle East countries all show increases. . . . ¶Texas Railroad Commission sets new record allowable for May. . . . New figure is fifth consecutive increase. . . . ¶Report on seven pilot studies of new production techniques presented before Oil Recovery Conference at Texas A. & M. . . .

TRENDS—Indicated demand at refineries for the four major products in 5-week period ended April 14 was 8.2 per cent greater than in same period last year. . . . ¶Major product stocks were reduced only 2,307,000 bbl. in 5 weeks compared with a drop of 17,286,000 bbl. in the same weeks of 1950. . . .

ACTIVITY—Crude production averaged 6,077,750 bbl. daily for week ended April 21, up 32,550 bbl. daily for the week. . . . ¶Total completions decreased 7 wells to 754. . . . Wildcat completions totaled 169 compared with 157 for same week last year. . . . ¶Rotary rigs operating in United States on April 16 totaled 2,303 compared with 2,305 a week earlier and 2,000 for same date last year. . . .

INTERNATIONAL—Abadan refinery operating at less than one-third capacity. . . . Loss of products throws oil companies operating abroad into Gulf Coast, West Coast, and Caribbean markets to obtain supplies. . . . ¶Lube facilities planned for Marifu, Japan, refinery. . . . ¶Pemex also announces plans for lube plant at Salamanca refinery.

REFINING—Shell Oil Co. acquires Woodbridge, N. J., site for new refinery. . . . President H. S. M. Burns says construction not to start for at least a year. . . . ¶NPA assumes complete control over supplies of sulfuric acid in 11 western states, prohibits use or delivery without specific authority. . . . ¶Shell to install large Platforming unit for production of aviation aromatics and benzene at Houston refinery. . . . ¶Discussion at Cleveland NPA meeting indicates shortage of additives may become acute. . . . Short additives supply is in prospect, but requirements are increasing. . . .

INDUSTRY—Getty interests, now holding majority of Tide Water stock, ask charter changes to give Getty close control of company operations. . . . ¶New test by Amerada of North Dakota discovery indicates production of more than 200 bbl. per day. . . . Leasing becomes active in eastern Montana and South Dakota with prices ranging from 25 cents per acre to $5. . . .

GOVERNMENT—FPC orders Phillips case hearing limited to determination of whether Phillips is a gas company under the Natural Gas Act. . . . ¶House schedules hearing on proposed extension of Interstate Oil Compact Commission. . . . ¶Washington sources estimate oil industry is prepared to spend 1½ to 2 billion dollars for expansion to meet defense and civilian requirements in near future. . . .

CONTINUING SEARCH.—Vegetation-crusted swamps and waterways are every-day challenges to oil-exploration personnel in their constant effort to locate for the drilling crews potential oil-bearing reservoirs. Here members of a Cities Service seismograph party is shown using a swamp buggy and pirogues to get through the swamps of southern Louisiana in their search for favorable formations under the swamp bed.

XUM

Exploration Meeting

Technical data, new ideas concerned with discovering oil presented before more than 3,200 scientists in St. Louis

Philip C. Ingalls

ST. LOUIS.—More than 3,200 scientists gathered here this week to participate in the joint annual meeting of the American Association of Petroleum Geologists (thirty-sixth), the Society of Economic Paleontologists and Mineralogists (twenty-fifth), and the Society of Exploration Geophysicists (twenty-first).

A special exploration section which includes E. A. Eckhardt's "Geophysical Activity in 1950," Frederick H. Lahee's "Exploratory Drilling in 1950," George E. Wagoner's presidential address, "Geophysical Frontiers," pictures of the officers-elect of the three exploration groups, and abstracts of many of the papers presented at this meeting may be found in this issue beginning on page 106.

The varied programs of the three groups of exploration men succeeded in presenting to participants a wealth of technical information, expecially new ideas and findings, beneficial in the continuing search for oil.

The programs.—Core of the A.A.P.G. program was a symposium on oil and gas reservoirs designed to provide additional means of attacking problems of reservoir behavior from the geologists' point of view.

The S.E.G. program covered the most recent advances in the techniques of geophysical prospecting for oil, experimental data, and case histories of geophysical surveys.

The S.E.P.M. program tied in closely with that of the A.A.P.G. in that many of this society's papers were on reservoir studies based on petrology and facies changes.

Outstanding among the 4-day meeting were the Tuesday joint sessions of the three groups.

The morning session featured an address by Secretary of the Interior Oscar Chapman, the presidential addresses of Clarence L. Moody (A.A.P.G.), William C. Krumbein (S.E.P.M.), and George E. Wagoner (S.E.G.), and presentation of A.A.P.G.'s presidential award, S.E.G.'s best-paper awards, and A.A.P.G.'s Sidney Powers Memorial Medal.

Moody's talk.—In his address as retiring A.A.P.G. president, Moody, of Ohio Oil Co., told listeners that from the standpoint of opportunity, the petroleum geologist engaged in research can justify his optimism that he seems to be in little danger of being left with no worlds to conquer.

The age-old problems of origin, migration, and accumulation of petroleum still await unique solutions, he said, and no dearth of technical problems is in prospect during 1951.

Reviewing with satisfaction the geologists' past accomplishments, Moody expressed only optimism for future opportunities to continue to expand their prestige and assure themselves of long-term employment.

Geology, Moody pointed out, has been of incalculable help in making possible the discovery of 70 billion barrels of oil in the United States alone since the Drake well. He said that the petroleum geologist may value himself highly, for his services are in growing demand.

The retiring president said that the petroleum geologist has tools which he has used but little, such as those fabricated by the sedimentary petrologists; that his most useful mechanical device is the drilling rig.

He said that by continuing his tried and true techniques and by judiciously expanding his use of this foremost geological tool, the petroleum geologist has reason for optimism respecting his chances of finding new petroleum reserves which are so urgently needed for hemisphere defense.

However, Moody concluded, the petroleum geologist can wholly justify complacence today only after he has geared his citizenship and integrated his individual specialties and skills with his nation's presently unfolding program of maintaining world peace.

Chapman's remarks.—The initial address of this joint session was given by Secretary Oscar Chapman.

Chapman told the group that the geologists are conscious of the difficulties of finding new oil, that the search is being pushed deeper and deeper, and that increasing technical difficulties must be surmounted such as in the search for offshore oil.

The interior secretary told of the Government's synthesis program and emphasized the importance of the Bureau of Mines' shale-oil-recovery work in helping to reach the increased production goal of the future.

Powers award.—If any single event of this meeting could be singled out as the most outstanding it would probably be the presentation of the Sidney Powers Memorial Award of the A.A.P.G. to Max Steineke, Arabian American Oil Co., San Francisco, in recognition of his distinguished and outstanding contributions to, and achievements in, petroleum geology in finding and developing vast oil resources in Saudi Arabia.

Steineke is the fifth recipient of the gold medal and scroll, signifying the highest honor in the science of petroleum geology. (Picture of Steineke on page 123.)

In a surprise announcement, honorary membership in A.A.P.G. was bestowed upon J. P. D. Hull, Tulsa, in recognition of 25 years of service as A.A.P.G. business manager.

Other papers.—Tuesday afternoon was devoted to papers of general interest to all three groups. These papers covered broad aspects of structure, stratigraphy, seismograph interpretation, and a new specific reservoir concept (see page 219).

Award Winners

M. W. QUARLES

DR. G. WOOLLARD

ST. LOUIS.—Walter B. Spangler and Jahn J. Petterson, of Creole Petroleum Corp., Caripito, Venezuela, this week were presented the A.A.P.G. President's Award for 1951. The award is made annually to the author or authors under 35 years of age of the "most significant original contribution to petroleum geology" published during the previous year in the monthly A.A.P.G. Bulletin.

The winning paper, selected by a national award committee headed by J. V. Howell, Tulsa, is entitled, "Geology of Atlantic Coast Plain in New Jersey, Delaware, Maryland, and Virginia." It was published in the January 1950 issue of the Bulletin.

Miller W. Quarles, Jr., United Geophysical Co., Houston, received the annual award of the Society of Exploration Geophysicists for the best paper on geophysics in 1950. The paper, "Fault Interpretation in Southwest Texas," was published in the July 1950 issue of Geophysics, the society's quarterly journal.

Dr. George P. Woollard, of the University of Wisconsin, received the S.E.G.'s best-paper honorable mention for his paper, "The Gravity Meter as a Geodetic Instrument." The paper appeared in the January 1950 issue of Geophysics.

XUM

Association leaders at last week's NPA meeting in Cleveland: W. S. Zehrung, NPA president and president of Pennzoil Co.; Fayette B. Dow, NPA general counsel; Rex Blazer, president of Ashland Oil & Refining Co.; and C. Z. Hardwick, vice president of Ohio Oil Co.

Shortages Are Possible!

Cold winter would mean difficulty, NPA is told; outlook in materials, transportation outlined at Cleveland meeting

Dahl M. Duff

CLEVELAND.—The oil industry must move every barrel of product as close as possible to points of consumption during the summer if the possibility of shortages next winter is to be averted, the National Petroleum Association was told here last week.

"If next winter is cold—and we haven't had a cold one for several years—we'll be in difficulties, and there's not much doubt of it," said D. B. Hodges, director of the supply and transportation division of Petroleum Administration for Defense.

In a talk at the association's forty-eighth semiannual meeting, Hodges described the close supply-demand margin on which the industry has been operating and emphasized the urgent need for further buildup, particularly in storage capacity. He pointed out that lack of storage makes for inefficient seasonal use of the industry's transportation facilities, overburdening them during peak winter-demand periods.

Materials outlook.—Bruce K. Brown, deputy administrator and top PAD official, reviewed the adequacy of the nation's oil supply from the standpoint of materials availability and in general arrived at the same conclusion. The oil is in the ground, but it has to be brought out, refined, and distributed, Brown said, and "I warn you now, gentlemen, unless we get these materials, we'll be in trouble."

Brown raised the question whether the industry has oversold the public on the theme that it is a big, strong, powerful industry that has met and will continue to meet every need regardless of conditions. He said this general attitude hampers the fight for sufficient steel and other materials.

The general feeling outside the oil industry is that oil men will somehow make out and that the necessary products will be forthcoming regardless, Brown said. W. S. Zehrung, NPA president, commented that possibly the Oil Industry Information Committee needs to reorient its program along the line that the oil industry must have the materials and then it can do its job.

The industry needs 470,000 tons of steel for tubular goods in the third quarter, and probably will get it, Brown said. Another 100,000 tons is needed for well equipment. There is a fair chance of obtaining this. Approximately 1,400,000 tons are needed in the third quarter for line pipe, of which about two-thirds is gas and one-third oil. This isn't assured, though the decision is due soon, Brown said.

Transportation outlook.—Hodges, in his discussion, outlined the industry's transportation facilities and what is needed. Pipe lines depend on line-pipe deliveries, but thus far only one new oil line has been badly set back.

Foreign tanker construction should release American vessels for domestic service, Hodges said. Tank-car deliveries are far below the substantial program planned, and this winter, trucks probably will have to take up the slack by a return to some extent to the wartime practice of truck use around the clock 7 days a week.

Lube price control.—Orville D. Judd, acting chief of the petroleum branch, Office of Price Stabilization, gave the first disclosure of the proposed new lubricating-oil price regulation. This follows the general pattern of other petroleum-price regulations, using as a basis the highest prices charged in the December 19-January 25 period.

A lubricating-oil supplier can apply for relief if his costs are up 5 per cent or more since last June. What adjustments will be made will be less any increases previously posted. Judd said the intention was to spell out area ceilings as soon as possible but that it was desired to come out from under the general price-freeze regulation quickly.

The proposed regulation, which Judd emphasized has not been finally approved, provides three methods of establishing prices of new products: by the minor-differences method, by the comparable products method, and by the final-price method. These are designed to allow a fair return with costs taken into consideration.

Speaking on the petroleum price-regulation situation generally, Judd said the industry was the only major industry to comply fully with the voluntary hold-the-line price request made last December. This fact is not generally appreciated, he added.

"I am honest enough to feel that profit absorption should not be made a part of the pricing picture," Judd said. "If a man is efficient enough to make more than his neighbor, he ought to be allowed to keep it."

Judd said OPA is working closely with PAD since it realizes that its rulings can disrupt petroleum supply. Answering a floor question, he said no consideration had yet been given to a stripper-well subsidiary such as in the last war but that he felt some such action was needed to insure marginal well production. He said his agency could not initiate such a request.

Deferment appeal.—Maj. Gen. Lewis B. Hershey, director of selective service, urged the NPA members to remember that every person who is deferred from service compels someone else to remain in longer. Out of 151,000,000 people in the country, about 148,000,000 are already deferred, and the choice is being made in a very narrow field.

Hershey warned that business and technical groups must make their professional classifications mean something. Some titles are useless, such as when the engineering classification goes down to include the apartment-house janitor. The deferment question must be approached with justice, Hershey said.

Freight rates.—Further increases in rail freight rates threaten a diversion of packaged-products shipments, especially lubricating oils, to bulk movement, Harry E. Elkins, NPA's traffic attorney reported. The Interstate Commerce Commission fails to recognize that petroleum shippers can move by barge into terminals, do canning

at that point, and ship out by truck into nearby territory. Elkins estimated that since the war petroleum freight rates have gone up over-all about 40 per cent. Eastern roads have taken greater increases than those elsewhere and, as a result, Elkins said, the situation is serious for those suppliers who rely largely on rail transportation.

More on manpower.—The need for a manpower setup in PAD to assist the industry in its deferment problems was discussed by the association's industrial-relations department. Sentiment favored regional groups to work on deferments.

Honors.—The NPA is the industry's oldest trade association and marks its fiftieth anniversary next year. At Cleveland, the association paid honor by resolution to the two living original members, Herbert G. Eaton and William Muir. Both men are now retired after long careers in the Pennsylvania refining industry, Muir last month having celebrated his 100th birthday in St. Petersburg, Fla.

Additives Problem

Requirements are up, supply short this year, NPA hears; further refining, less additives use may be necessary

CLEVELAND.—The full range of the subject of additives for lubricating oils was explored by speakers at a technical session of the National Petroleum Association's semiannual meeting here April 20.

Ten separate papers were given by representatives of the military, the Petroleum Administration for Defense, additive and engine manufacturers, and oil companies. Some highlights:

1. The 1951 requirements for additives are up substantially, and a short supply is in prospect because of shortage of basic raw materials, such as sulfuric acid and benzene, increasing additive concentration, and greater lubricating-oil production.

2. The argument that it is more economical to use a high-additive oil than to further refine the fuel is questionable in the view of the military; with no easily obtainable additional additive supply, it may be unsound for a war economy.

3. High-detergency oils are not a cure-all for light-duty engine problems, and a few "additives" in the way of engine design can accomplish results not possible to obtain wholly through oil additives.

What's in prospect.—Preliminary check of a questionnaire by PAD on additives shows prospective use of detergent additives up 47 per cent in 1951, and of antioxidants, 20 per cent, T. L. Apjohn, assistant director of PAD's refining division, told the joint session of the association's departments of manufacture and standards and tests.

In 1950, about 122,000,000 lb. of detergent additives were used in premium service-station lubricating oil and in heavy-duty oil, and the same lubes used nearly 31,000,000 lb. of antioxidants, Apjohn said. Refiners expect to use in 1951 about 180,000,000 lb. of detergents, and 40,000,000 lb. of antioxidants. If all premium grade service-station oil went to heavy-duty military specifications, about 260,000,000 lb. of detergents would be required this year.

The PAD official pointed out the petroleum industry is facing curtailment of sulfur consumption, now going to four uses: alkylation, catalyst manufacture, treating, and additive manufacture. The last two uses must absorb the decrease since the first two are more essential to defense, and it is questionable whether acid treating can be reduced substantially

Dr. Carl W. Kelley, of the Office of Petroleum Programs of the Munitions Board, told the meeting that the increasing additive content of lubricating oils has been largely caused by fuels of high sulfur content and different compositions. He urged a more careful study of improving fuel quality as against the more expensive oils.

Military needs.—Kelley said military requirements for 1951-52 amount to 114,700 bbl. of additives and 72,000 bbl. of sulfonates with possible peak emergency requirements of 447,000 bbl. of additives and 330,000 bbl. of sulfonates. He said some of the newer synthetic methods of sulfonate manufacture should be thoroughly investigated.

Another military representative, Capt. W. C. Latrobe, of the Navy's Standards and Specifications Division of the Bureau of Ships, made it clear the services will take first call, if necessary, on additives that are now going into service-station oil.

C. J. Livingstone, director of products development, Gulf Oil Corp., said he was opposed to a motor-oil classification for service-station customers based on additive content or a diesel-engine test. "The automobile manufacturers' problem of recommending lubricants is recognized, but until classifications can be made on a sound technical basis, perhaps we should go a little slow in any effort in this direction," he said. He added he hoped the industry would not allow military requirements to dictate the course of development of service-station oil.

Engine design.—The comments on possible engine "additives" were made by Carl W. Georgi, Quaker State Oil Refining Corp., who is vice president for the S.A.E. fuels and lubricants activity.

Speaking on the topic, "Is All This Detergent Oil Really Necessary," he said: "Whether we like it or not, we're still having plenty of trouble in very light-duty operations, and high-detergency oils aren't doing any outstanding job in such service. When we start looking for the reasons why high-detergency oils fall down in light service, we find that all too many engines aren't really designed for very light-duty operation."

He cited three factors which can make or break a motor oil in light-duty service: constant circulation bypass around the thermostat in the cooling system; inadequate crankcase and valve-compartment ventilation, and either no oil filter or an inadequate one.

H. C. Mougey, technical director of General Motors Corp.'s research-laboratories division, said General Motors is doing what it can to encourage oil companies to mark oil containers to tell the purchaser their A.P.I. classification—regular, premium, or heavy duty.

Refinery men at the Cleveland NPA meeting included this group: R. W. Pollard, general superintendent, Leonard Refineries, Inc., Alma, Mich.; Russell Potts, manager, refinery division, Indiana Farm Bureau Cooperative Association, Inc., Mount Vernon, Ind.; E. E. Thompson, vice president in charge of manufacturing, Mid-West Refineries, Inc., Alma, Mich.; and Howard Salisbury, assistant personnel director, Kendall Refining Co., Bradford, Pa.

Electric Show

New equipment items seen at P.I.E.A., P.E.S.A. meeting

DALLAS.—The twenty-third annual conference of Petroleum Industry Electrical Association and Petroleum Electric Suppliers Association brought out elaborate displays of the latest in electronic gadgets for the oil industry here last week and attracted more than 500 members and guests.

A major portion of the show, which now has grown into an exposition in its own rights, was devoted to microwave - communication systems and two-way radio. Working displays reflected great strides made by that phase of the electrical industry, pertaining to telephone, telegraph, telemetering, remote control and many other uses.

There were speakers who stressed the importance of making full use of the electron tube in its many applications, with a view toward economics as well as in the release of workers from hazardous, monotonous or repeat-operation duties.

Microwave transmission of communication messages, such as used today by many pipe-line companies along their pipe-line right-of-way relaying messages from end to end of the line, plus telemetering service at pump stations, was pointed out as relatively expensive to install, low in maintenance cost, and the most dependable of all systems in operation.

Industrial television was one of the newer items on display. The unit makes use of a small camera which has all its operations remotely controlled from the viewing screen and monitor, the latter device being located conveniently away from the camera.

While it is being employed in other industries, practical use in the oil industry probably will be found in laboratories for keeping close visual check on difficult operations; or in oil refining where one man, from one point, can check on an unlimited number of control panels.

New officers.—New officers chosen by the P.I.E.A. group were: A. L. Stegner, Tennessee Gas Transmission Co., Houston, president; H. G. Pegues, United Gas Pipe Line Co., Shreveport, vice president. W. H. Massey, Interstate Oil Pipe Line Co., Shreveport, was reelected secretary-treasurer.

New officers for the P.E.S.A. group are: Howard L. Housley, Automatic Electric Sales Corp., Chicago, president; R. C. Stueve, consultant, Oklahoma City, vice president; and H. L. Renking, Electric Machinery Manufacturing Co., Dallas, secretary-treasurer. The meeting next year will be held in Tulsa.

Two speakers are shown here addressing the joint P.I.E.A.-P.E.S.A. meeting in Dallas. At left is Donald G. Fink, editor of the publication, Electronics, New York City, who spoke on "The Future of Electronics in Industry." At right is R. F. Lay, installation engineer, Cooper-Bessemer Corp., Mount Vernon, Ohio, who addressed the meeting on the subject, "Electronics in the Public Interest."

Gas Confab

S.G.A. told about new gas turbine, microwave costs

BILOXI, Miss.—What's new in natural - gas transmission, accident prevention, sales, employe relations, distribution, accounting, and operating equipment was outlined here this week before natural-gas men attending the forty-third annual convention of the Southern Gas Association.

Microwave costs.—E. B. Dunn, Keystone Pipe Line Co., Philadelphia, gave transmission men a basis for determining whether they might profitably employe microwave installations on their pipe-line systems.

In a highlight of the transmission session, Dunn said competition in the microwave field has made it possible to install a simple microwave system in flat country for about $600 per mile with eight through channels.

Annual maintenance costs were estimated by Dunn at $200 per mile for a 150-mile mountainous system or $150 per mile for a 200-mile flat-country system.

Figuring annual costs for leasing telephone circuits at about $75 per line mile, Dunn said "you must have need for either two or three leased circuits before you could make an economic justification of a microwave system."

However, he pointed out, parallel systems could form a joint system operated on a cost-sharing basis.

Combustion turbine.—M. E. Orelup, Oklahoma Natural Gas Co., told the gas men that the combustion gas turbine has proved itself in operation as a new type of prime mover and that it has "an excellent possibility" of becoming "an important consumer of natural gas."

Orelup described the first combustion-gas-turbine installation by a utility company—that of Oklahoma Gas & Electric Co. at Oklahoma City—and said that its 13,000 hours of operation to date had proven that: Investment costs are reasonable; operating costs are very satisfactory; maintenance costs are comparable with any other type of prime mover; it is very dependable and has high availability; and natural gas is the best fuel for operation.

Tide Water Deal

Getty, with majority of stock, asks charter changes

NEW YORK.—Changes in the corporate charter of Tide Water Associated Oil Co. have been proposed by the J. Paul Getty interests which have increased their holdings of Tide Water stock to slightly above 50 per cent.

Tide Water's proxy statement disclosed that the changes sought would prohibit the management from entering into any employment contract with an officer or director for more than 1 year, from issuing any additional shares of common stock, or from incurring any debt of more than 1-year maturity of $15,000,000 or more, except for purchases made in the ordinary course of business.

These restrictions would hold unless consent of a majority of the stockholders were obtained.

Observers of the company's financial affairs in New York said these charter changes would allow Getty to hold close control over the company's affairs without actually becoming a director or officer.

The recent annual report of Pacific Western Oil Corp., of which Getty is president, revealed that this company, together with the affiliated Mission Corp. and Mission Development Co., now holds 50.12 per cent of Tide Water. At the end of 1949, the Getty interests held about 39 per cent of Tide Water.

Mineral-Rights Tax Killed

BISMARCK, N. D.—The North Dakota Supreme Court last week ruled against a section of law which authorizes counties to tax mineral rights held apart from the land they cover.

In the case of Northwestern Improvement Co. vs. Morton County District Court, the high court upheld the decision of Judge Harvey J. Miller who ruled for the plaintiff.

The law in question provides a privilege tax of 3 cents an acre on mineral rights held separately from the land to which they apply, when they are retained as a result of other than direct conveyance.

ROCKY MOUNTAIN

Rush for Leases

Major companies buy 25 million acres in North Dakota; two more states involved; new test run on discovery well

WILLISTON, N. D. — A rush for leases in the Williston basin has developed into a three-state play since the discovery of oil 32 miles northeast of here by Amerada Petroleum Corp.

The western two-thirds of North Dakota, the eastern fifth of Montana, and the central portion of South Dakota are involved in the play that today holds the exploration spotlight in the United States.

The favorable part of the Williston basin is expected to be under lease within the next 90 days.

Major companies represented in the play besides Amerada include Atlantic Refining Co., Carter Oil Co., Continental Oil Co., Gulf Oil Corp., Magnolia Petroleum Co., Phillips Petroleum Co., Plymouth Oil Co., Pure Oil Co., Shell Oil Co., Sinclair Oil & Gas Co., Standard Oil Co. of California, Standard Oil Co. (Ind.), Standard Oil Co. (Ohio), and Union Oil Co. of California.

North Dakota.—More than 23 to 25 million acres out of the state's 45 million acres is now under lease, a major buyer states. He said that from 80 to 90 per cent of Williams and McKenzie counties are under lease. More than 100 lease men are active in the Williams-McKenzie counties sector near the discovery well filling in blocks and obtaining checkerboard spreads for later comers to the play.

Buying crews are located in nearly every county seat town starting from the northwestern corner of the state and crossing the state in a southeasterly direction into South Dakota. Currently, the eastern limit of buying is reported here to be a line which starts with the eastern boundary of Benson County, swings south to the east line of Eddy and Foster counties, then cuts across the southeastern corner of Stutsman and around to the southeast corner of McIntosh County.

Minimum prices paid for leases are 25 cents an acre and 25 cents annual delay rental. A source interviewed said that "the next day, prices are up to 50 cents, then $1, then shoot up to $3, and in some cases $5." Primary lease terms are specified at 10 years.

South Dakota. — The play swings southeastward into the southeast limb of the Williston basin into South Dakota. Progressively, the activity embraces Corson, Perkins, Harding, Dewey, Ziebach, and Armstrong counties. There is limited activity in the counties of Jackson and Haakon near the southern limb of the basin. On the northeast limb of the Black Hills uplift, in the western part of the state, some leasing is in progress in Butte and Meade counties.

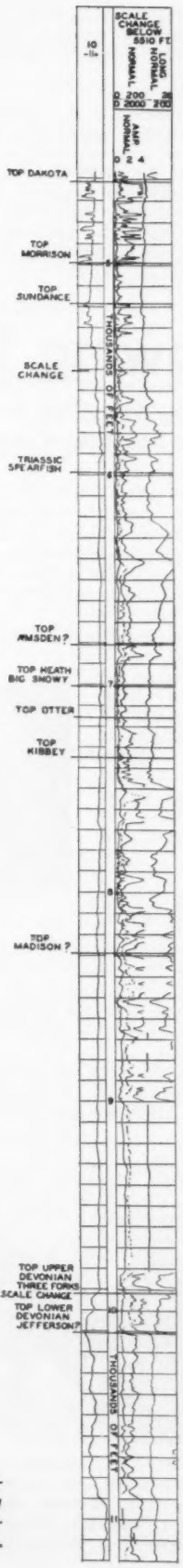
Montana.—Leasing has extended into the eastern border counties of Montana with activity noted in Sheridan, Daniels, Roosevelt, Richland, Dawson, Wibaux, and Fallon counties. The Williston basin extends into northeastern Montana and is interrupted by the Baker-Glendive anticline, which cuts across that area in a northwest-southeasterly direction. The Amerada discovery well lies about 50 miles east of the Montana state line.

New gage on discovery.—Meanwhile, Amerada Petroleum Corp. last week repaired a split tubing joint and reran tubing in its 1 Clarence Iverson, C SW SW 6-155n-95w, 8 miles south of Tioga in Williams County. After the load oil was recovered, the well flowed 208 bbl. of 53.4° A.P.I. gravity oil in the 18-hour period ending 6 a.m., April 20. The well was flowed through a ¾-in. choke on 2-in. tubing.

Gas volume measured 1,895 M.c.f. per day and the gas-oil ratio was 9,111 cu. ft. per barrel. Tubing pressure reached a maximum of 400 psi. for the twelfth hour of the gage and measured 200 psig. during the last hour of the test. On last report, the well flowed 108 bbl. of 55.2°-gravity oil in 8 hours through a ½-in. choke after reacidization with 8,000 gal.

There are two 1,000-bbl. tanks erected at the well. Crude oil will be trucked about 11 miles north from the discovery well to Miracle, a spur 3 miles northwest of Tioga on the Great Northern Railroad where it will be transferred to tank car for shipment to Northwestern Refining Co. refinery at St. Paul Park on the Mississippi River adjoining St. Paul, Minn. Two cars had been shipped from Tioga, 8 miles north of the well, but it was found that this point was too close to the main line for handling.

Morton County wildcat. — Williston basin drilling interest was shared with a rank wildcat test 148 miles southeast of the Amerada-Iverson discovery well. Phillips Petroleum Co. and Carter Oil Co. 1 fee, C NE NW 29-136n-81w, 10 miles north of



Electric log of portion of well bore of Amerada's North Dakota discovery showing formation tops. Portion of log presented covers the section from 4,500 ft. to 11,200 ft. The producing horizon was not logged.

St. Anthony in eastern Morton County, was drilling around 5,700 ft. and was reported in Bismarck as "a tight hole."

Taxes proposed. — A proposal that North Dakota's Legislature be called into special session to enact a per-barrel tax on crude oil from North Dakota found little support last week. Howard Henry, Westhope, Democratic candidate for governor in 1948, author of the proposal, believed that the legislature should not wait until the next regular session is held in 1953.

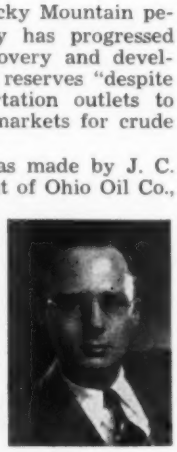
However, most legislators were cool to the proposal. Sen. Rilie R. Morgan, Grafton, senate majority leader, thought that it would seem off-hand that "there's no particular rush on oil legislation," while Rep. John Fleck, Bismarck, believed that not enough oil production would be developed before the regular 1953 session to necessitate a special gathering, an action he termed an "unnecessary expense."

Growing Reserves

Rocky Mountain output up 175 per cent in 10 years; area now has excess capacity, Casper A.P.I. meeting is told

CASPER.—The Rocky Mountain petroleum industry has progressed steadily in the discovery and development of crude-oil reserves "despite inadequate transportation outlets to the nation's major markets for crude oil."

This statement was made by J. C. Donnell, II, president of Ohio Oil Co., Findlay, Ohio, before 400 oil-industry men at the spring meeting of the Rocky Mountain district of the American Petroleum Institute production division held here last week.



J. C. DONNELL, II

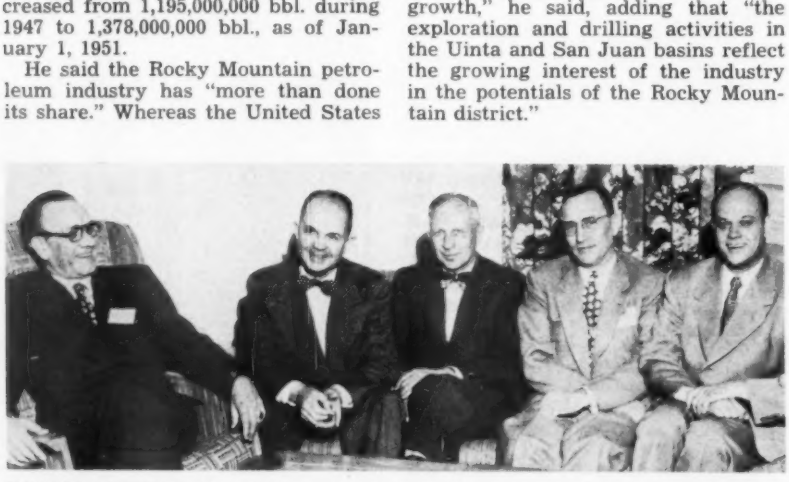
Donnell, who is A.P.I. vice president for production, said that petroleum reserves for the states included in District 4 (Rocky Mountain area) have been increased from 1,195,000,000 bbl. during 1947 to 1,378,000,000 bbl., as of January 1, 1951.

He said the Rocky Mountain petroleum industry has "more than done its share." Whereas the United States has increased its production 53 per cent during the past 10 years, the Rocky Mountain area has shown a jump of 175 per cent. As a result, the proportionate share of the nation's crude oil produced in the Rocky Mountain states has grown from 2.4 per cent to 4.3 per cent.

Excess capacity. — Citing the Rocky Mountain district as one of the few areas in the nation which has a substantial backlog of excess productive capacity in relation to current production, Donnell said every effort should be made to tap this capacity by constructing additional pipe-line facilities.

The A.P.I. official predicted that "we may expect a continuous re-exploration on a more intensive scale throughout the district."

"The development of production in western Nebraska and the recent discovery in western North Dakota are significant examples of lateral growth," he said, adding that "the exploration and drilling activities in the Uinta and San Juan basins reflect the growing interest of the industry in the potentials of the Rocky Mountain district."



***HONORED BY A.P.I.**—Recipients of awards for outstanding contributions to Rocky Mountain district activities after receiving the awards in Casper. Left to right are W. M. Saxon, representing M. C. McArthur, Husky Refining Co., Cody, Wyo., who was unable to be present; D. T. Hoenshell, General Petroleum Corp., Casper; J. C. Johnston, Continental Oil Co., Denver; J. D. Anderson, Ohio Oil Co., Casper; and Zack Brinkerhoff, Brinkerhoff Drilling Co., Casper.*

Defense setup.—Millard K. Neptune, assistant director of the production division of the PAD, said that the organization of defense agencies in the mobilization program can be understood better if we consider them as covering three levels of activity, which may be termed (1) executive direction and coordination, (2) policy control and planning, and (3) administration.

The policy-making responsibilities of Secretary Oscar L. Chapman and Deputy Administrator Bruce K. Brown were cited by Neptune as "fitting ODM and DPA policies to over 300 refiners, 18,000 to 20,000 producers, some 240,000 marketers, and 150,000,000 users of petroleum and gas."

Water injection.—The application of controlled withdrawals and water injection in the Shannon Sand reservoir of Cole Creek field, Wyoming, have resulted in the recovery of more than 400,000 bbl. of oil to date which would not have been recovered by pressure depletion alone. This conclusion was developed by E. J. Whitaker and D. T. Hoenshell, petroleum engineers, General Petroleum Corp., Casper, Wyo.

They noted that a total of 670,000 bbl. of water have been returned to the reservoir since water injection was initiated on February 6, 1946, and that the total injection rate has averaged 1,100 bbl. per day since August 1950.

The engineers predicted that the efficiency of recovery will ultimately exceed 36 per cent of the oil in place and that more than one million barrels of additional oil would be recovered by artificial water injection and controlled withdrawals.

Uinta Basin.—More than 350,000 bbl. of oil has been produced from two wells to date from Roosevelt pool, the first discovery in the Uinta basin, in northeastern Utah. The field was discovered in June 1949. The reservoir is unique in that the recoverable oil is dependent entirely upon fractures in the so-called "oil shale" of Green River formation of nonmarine Teritiary sediments, said E. A. Polumbus, Jr., Carter Oil Co., Denver, who added that the crude, although of medium gravity, contains approximately 40 per cent paraffin and has a pour point of 90° F.

New advisory committee.—New members of the advisory committee are R. S. Shannon, Jr., Pioneer Oil Co., Denver; B. F. Hanly, Reed Roller Bit Co., Casper; Gilbert Mueller, Argo Oil Corp., Denver; Lee Kelton, Black, Sivalls & Bryson, Inc., Casper; J. L. Dougan, Equity Oil Corp., Salt Lake City; J. G. Dyer, Dyer Drilling Co., Denver; W. T. Nightingale, Mountain Fuel Supply Co., Rock Springs, Wyo.; T. T. Freeman, The Texas Co., Denver; A. P. Lacey, Continental Supply Co., Casper, and R. L. Manning, R. L. Manning Co., Denver.

Materials Outlook

June tubular-goods allocation to permit drilling at rate of 43,000 wells per year; third-quarter allotments issued

Bertram F. Linz

WASHINGTON. — An allocation of 140,000 tons of steel for June production of oil-country tubular goods is included in projects provided for by the Defense Production Administration. The oil-country tubular goods allocation is part of approximately 1,400,000 tons to be made available for 24 special programs needed to expand production for defense and essential civilian needs.

While slightly less than the 141,750 tons earmarked for tubular-goods production in May, DPA said the June allotment represents capacity output of the mills. Petroleum Administration officials, however, estimate that June production of tubular goods will reach 154,600 tons, all of which will be made available for oil and gas-well drilling.

Other allotments.—In addition to the tubular goods allotment, DPA has provided 17,000 tons of steel for well-head equipment and 66,000 tons for 55-gal. drums and pails, both figures the same as for May. Also, on the basis of a canvass of manufacturers conducted by PAD, DPA is setting up a program to provide spot assistance for the production of equipment for petroleum discovery and development, for which 34,000 tons of steel will be made available.

Other programs provide steel for the production of 850 tank cars, as against 725 in May, and 320 diesel locomotives, the same as contemplated for next month. Another 23,000 tons of steel will go into barges and towboats, against 23,700 tons for May, which will permit the production of 25 barges each month.

The highway-tank-transport program was promised spot assistance, when necessary, in obtaining steel for the production of 460 vehicles, needed primarily for the short-hauling of petroleum products, up to a ceiling of 2,000 tons in June.

DPA officials said the programs to provide steel for tubular goods and well-head equipment will permit the drilling of new oil and gas wells during June at an annual rate of 43,000.

Operators notified.—All oil and gas operators who made applications for allocations of oil-country tubular goods have been notified how much steel they will be given for the third quarter.

Authorizations issued, based on applications filed on Form PAD-15, will permit operators to place priority rating DO-48-E on orders for casing and tubing to be delivered from emergency field stocks for drilling wildcat wells. Similar authorizations, based on Form PAD-17 applications, will permit use of the DO-48 rating on orders to be delivered from the regular rollings of steel-pipe mills for third-quarter oil and gas-drilling programs.

Each authorization shows the tonnage of casing and tubing which the individual operator will be permitted to acquire from field stocks, or during the third quarter from pipe mills.

Quotas exceeded. — Computations by PAD showed that the applications filed for tubular goods called for enough material to drill at an annual rate of from 72,000 to 75,000 wells, or over two-thirds more than the program calls for. The 43,400-well target will be attained if the current rate of drilling can be maintained, but not enough steel is available 'and it will be possible to maintain the drilling rate only by using pipe secured from inventories, through imports, and through the use of second-hand pipe and line pipe instead of casing in shallow wells.

Oil and gas operators are willing to step up the drilling rate substantially and have enough proven locations and drilling rigs to do so, Deputy Administrator Bruce K. Brown said, but the shortage of tubular goods will prevent any expansion beyond the present rate.

Rolling mill pressure.—Brown pointed out that casing and tubing is rolled in only a small number of mills and must be made available for many activities other than domestic drilling. These include supplies for a large volume of foreign oil drilling, the drilling of sulfur, brine, helium, and hazardous-formation deep-water wells, and mining exploration. These activities require nearly 25,000 tons of casing and tubing a month.

Brown said that operators receiving authorizations to place delivery orders against PAD-17 applications may file supplementary requests if they find it impossible to carry out their third-quarter drilling programs with the materials available under their initial authorizations, plus materials otherwise available to them. He promised that operators will be notified within 2 weeks of the action taken on such requests.

Materials moving.—Casing and tubing is now moving from pipe mills to the 13 regional warehouse centers where tubular goods will be made available to operators for wildcat wells against PAD-15 authorizations, Brown said. In order to encourage exploration, these field stocks will be held for wildcat drilling only, unless it becomes evident that sufficient quantities are available to permit their use in emergencies for extensions to proven fields and to meet offset-drilling obligations.

Quebracho Squeeze

NPA says drillers must find acceptable substitutes

WASHINGTON. — Consumption of quebracho in oil and gas well drilling will be cut back sharply under a new National Production Authority order. The order restricts drillers during the current quarter to 60 per cent by weight of their average quarterly use during the first half of 1950.

The order, M-57, will make it necessary for the industry to resort to substitutes, which NPA said could include calcium ligno sulfonate and various pyrophosphates.

The order gives drillers a period for changing to substitutes by permitting them the unrestricted use of any quebracho held in inventory on the effective date, April 16, or in transit to him under any purchase order placed prior to that date.

The order is designed to conserve vegetable tanning materials, of which quebracho is the most important, for the production of leather and certain other items in which it has no substitute. About half the quebracho, imported from Latin America, is used by the oil and gas industries, and the remaining half furnishes approximately 55 per cent of the tanning-materials supply of the leather industry.

Acid limitations.—NPA also issued its expected order placing sulfuric acid under limited allocation, requiring that specific authorization must be secured for its delivery or use in the states of Washington, Oregon, California, Arizona, New Mexico, Nevada, Utah, Colorado, Wyoming, Idaho, and Montana, and directing purchasers in all states to certify to suppliers the end uses to which the chemical will be put.

Lack of adequate productive capacity to meet local needs and difficulty in transporting sulfuric acid from distant plants are the primary causes of a severe shortage in the Far West, but there is a shortage nationally and eventually end-use controls will be imposed, NPA said.

Steel Pinch

Key government men warned that oil-for-defense program is based entirely on assumption that there will be steel

WASHINGTON.—Key men in government were warned last week by PAD officials that development of an adequate supply of oil and gas for the defense program depends entirely upon the availability of steel.

At a special session for high officials of the Defense Department, National Production Authority, and Defense Production Administration, and members of Congress, the high spots in the oil and gas situation were outlined.

These top officials were told that an inadequate supply of steel anywhere along the line from wildcatting to filling station could cause an interruption of product distribution that could adversely affect defense production.

On thin ice.—Even with the steel for which bid has been made, Deputy Petroleum Administrator Bruce K. Brown said in opening the meeting, the oil supply will be adequate only for the defense program and not for an all-out war. At that, he commented, we are skating on thin ice as evidenced by current uncertainty over the future supply of oil from Iran.

Pointing out that we do not now enjoy the production cushion of more than 1,000,000 bbl. daily with which we went into the last war, Ralph Curtis, of the production division, explained the necessity for drilling the 43,400 new wells programed for this year with the consequent need for assistance that the required tubular goods and equipment will be available.

Gas needs.—Of the three segments of the gas industry — manufactured gas, liquefied petroleum gases and natural gas—the last presents the greatest problems, it was brought out by Charles P. Rather, assistant deputy administrator for gas.

Large amounts of pipe and accessory equipment must be made available and soon, Rather said, if natural-gas distribution is to be expanded to the degree necessary to eliminate industrial shut-downs in severe weather next winter.

Throughout the area served with natural gas, he told the meeting, the steel industry is highly dependent on that fuel and any interruption of supply necessitates the closing of plants, reducing the production of steel for the oil and gas industry and so further retarding the expansion of fuel supplies—a vicious circle which could have serious effects on defense.

Refining needs.—The need for developing an additional 700,000 bbl. daily more refining capacity by the end of 1950 and 1,000,000 bbl. by the end of 1953 was discussed by Reid Brazell, director of the refining division, who pointed out that even this would be sufficient merely to meet initial demand in the event of an outbreak of war.

Transportation needs.—There are 258 tankers under the U. S. flag, but continuing construction is imperative, as is the building of oil barges, tank cars, trucks, and storage facilities, it was declared by William P. Hayes, assistant director of the supply and transportation division.

The problem of distribution, Hayes explained, is purely one of transportation, and it was a shortage of transportation and not of oil, he pointed out, that was responsible for the spot shortages experienced this winter in several sections of the country.

The present program, Hayes said, will provide for the production of 25 barges a month in May and June and must be continued thereafter. The tank-car program is lagging, with less than 200 cars a month delivered during the first quarter. There is a need for 80,000,000 bbl. of new storage this year but only 40,000,000 bbl. is in sight unless more steel is provided.

Used Pipe Pricing

WASHINGTON. — Representatives of dealers in used oil-country tubular goods recommended last week that existing practices regarding markups over cost be continued in any pricing regulation issued by the Office of Price Stabilization.

At the first meeting of the newly appointed industry-advisory committee with OPS officials, discussion centered around rules to be imposed on such used material as casing, tubing, drill pipe, and drive pipe in a proposed regulation covering the resale of iron and steel products. There was no discussion of actual dollar-and-cents prices, since a regulation covering sales by iron and steel mills has not yet been issued.

OPS officials present at the conference, who outlined the objectives of the price regulations now being issued, included Charles Potter, metals-branch consultant, who presided; C. R. Wasson, economist; and I. C. Lambert and E. J. Dickson, consultants. Charles P. Reichert of the PAD materials division also participated.

Industry-advisory-committee members include D. D. Bovaird, Bovaird Supply Co., Tulsa; Frank L. Herefore, Murray Brookes, Lake Charles, La.; Fred F. Murray, Oil Well Supply Co., Dallas; J. H. Lollar, Jr., Republic Supply Co., Houston; A. W. McKinney, National Supply Co., Toledo; Jerry Vinson, Industrial Supply Co., Wichita Falls, Tex.; K. W. Davis, Mid-Continent Supply Co., Fort Worth; Sol Brachman, Producers Supply & Tool Co., Fort Worth; H. B. Wehrle, McJunkin Supply Co., Charleston, W. Va.; Jene P. Harper, Franklin Supply Co., Chicago, and Markley C. Brown, Hillman-Kelly, Los Angeles.

Compact Extension Hearing

WASHINGTON.—The House interstate commerce committee will hold a hearing May 3 on extension of the Interstate Oil Compact Commission.

Measures providing for extension of the agreement have been introduced in the House by Reps. Oren Harris of Arkansas and Lindley Beckworth of Texas, both members of the committee, and in the Senate by Sen. Tom Connally of Texas.

FPC Limits Phillips Case

WASHINGTON.—A determination whether Phillips Petroleum Co. is a natural-gas company subject to regulation under the Natural Gas Act should precede any consideration of its rates, the Federal Power Commission agreed last week.

An order to that effect was issued by the commission April 17, in line with a motion made by the company March 27. The FPC said informal instructions had previously been given the presiding examiner at the hearings which opened at Bartlesville, Okla., April 3 to limit them to the jurisdictional issue pending a ruling.

In its motion, the company asserted that before the commission goes into the matter of rates it must first hold that it has jurisdiction, and to hear both issues at the same time would require the expenditure of large sums of money by both the FPC and the company.

At the same time, it contended, the joining of the two issues would delay a ruling on jurisdiction, "thus unduly extending the doubt and confusion now confronting the public and the oil and gas industry."

Phillips' motion was supported by the officials of a number of states and by several oil and gas associations, but was objected to by officials of numerous cities and the State of Wisconsin, where Phillips' gas is consumed.

NPA Setup Revamped

WASHINGTON. — The National Production Authority has been revamped to increase the number of industry divisions from 20 to 35, to group related units under four operating heads, and to give industry-division directors greater representation in policy determination.

Heretofore, all industry divisions

More than America spent to win its Independence

THE Revolutionary War lasted 8 years and its direct cost was $74,555,642.

This sum is considerably less than the amount Youngstown is spending on expansion--its share of the steel industry's program to help preserve America's 175-year-old freedom from Communistic attack.

Work on a $90,000,000 construction project at the Indiana Harbor Works, East Chicago, Indiana, is under way. It includes a 1500-ton blast furnace, 75 new coke ovens and 8 - 250 ton open hearth furnaces, heating furnaces, a high-lift blooming mill, with 6 - 3 hole recuperative soaking pits, ore dock extension, unloaders and ore bridge, and a vast array of other facilities needed to produce the additional 1,000,000 ingot tons of steel involved. By the end of 1952, the steel industry expansion program will raise the total steel producing capacity of the United States to over 117-million ingot tons. This is more steel than is made in all the rest of the world combined.

This tremendous investment by the shareholders of private industry is possible only with adequate profit--profit earned in the past and to be earned in the future. This is a symbol of public confidence--confidence that the American system of free enterprise is right *and worth saving.* Confidence that it will continue to be our way of life through the years ahead.

Scrap Metal is Critical Again

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WATCHING WASHINGTON

Bertram F. Linz

Tidelands Finagling

New moves are reportedly under way by Sen. Joseph C. O'Mahoney of Wyoming to split the opposition to his bill for interim federal management of the tidelands.

O'Mahoney reportedly is circulating proposals designed to line up the support of the oil industry and weaken the opposition of Texas. Department of Justice officials are represented as not opposed to the proposals.

The exact nature of O'Mahoney's plan has not been revealed, but it is said to include a provision along lines suggested by oil men to permit the Secretary of the Interior to make leases in the Gulf but giving the states the right to veto.

The effort to win the consent of Texas to the O'Mahoney bill is said to be in the shape of an offer of 37½ per cent of revenue from the tidelands clear out to the Continental Shelf, to be provided for by a clause holding the national and state boundaries to be coextensive.

Controls in Babylon

In tackling the job of fixing prices, Price Control Director Michael V. DiSalle is maneuvering over an old and intensively mined battlefield, according to Walter Chamblin, Jr., Washington vice president of the National Association of Manufacturers.

Chamblin, a gentleman of inquiring mind, recently delved into the history of price fixing and found that, while it isn't quite as old as the proverbial hills, it can be traced 4,000 years. Here is what he found:

In the years 2285 to 2242 B.C., the Babylonians had wage controls for boatmen, reapers, shepherds, laborers, artisans, bricklayers, tillers, stone cutters, milkmen, and carpenters. It brought Babylon poverty and higher taxes.

The Hittites, 1,000 years later in 1350 B.C., unmindful of the Babylonian experience, established wage and price controls and ended up the same way.

The Roman emperor, Diocletian, tried the same thing. His edict read like that promulgated by Mr. Roosevelt some years ago and by Mr. Truman some months ago. In May of 305 A.D., Romans had had enough of Mr. Diocletian's wage control law, and they kicked it out.

Another 1,000 years went by. Henry III and George II placed price controls upon grain and bread. Bread disappeared, and Parliament junked the controls. Later, Edward II tried to control the price of sea food—and suddenly there was no sea food.

France put controls upon 39 necessities of life. This did nothing more than start a revolution.

Our forefathers tried the same experiment in Virginia and Massachusetts in colonial days. It didn't work. A hundred years later the Continental Congress sought to control Revolutionary War prices. The law was repealed in 1788 when the congress found control to be ineffective and "productive of evil consequences."

Nine years ago we embarked on another price-fixing program. It made a lot of black marketers rich. And now we are off for still another whirl on the merry-go-round.

German Shipping

Shipping and labor interest are deeply concerned over the possibilities that Germany will build a big fleet of tankers and merchant vessels as a result of the recent removal of all except military restrictions on German shipping and shipbuilding.

In a letter to the President, 10 organizations have protested that it would be a "grave error" to permit Germany to develop a merchant marine disproportionate to her requirements

Under the Potsdam agreement of August 1945, the production of oceangoing vessels was prohibited and only construction of slow, small coastwise vessels was permitted. Two years later, however, the Allies allowed German ships to enter into foreign trade over a limited area, and in April 1949 the Washington agreement authorized the construction of 12-knot 7,200-ton tankers and the acquisition abroad of up to 100,00 tons of 14-knot, 7,200-ton tankers.

In June 1949 all restrictions on Germany's foreign-trade area were lifted, and in November 1949 the High Commissioners agreed to permit the building of 7,200-ton tankers without limitation. This month all restrictions on the size, speed, tonnage, and number of vessels built or acquired by Germany were removed. As a result of the progressive easing of restrictions, the German fleet has increased from about 300,000 tons in 1949 to 650,000 tons now and is planned to be further increased to 800,000 tons in the near future.

administering orders and regulations concerned with production and distribution have operated in an Industry Operations Bureau. This has been abolished. The new setup will align the administrative structure to conform with established industrial organization. It will also make possible close relationships between NPA officials and industry executives in carrying out the new Controlled Materials Plan, it was explained.

Under the reorganization, oil and gas-industry machinery and equipment will be handled in an Industrial and Agricultural Equipment Bureau under Franz T. Stone, president of Columbus McKinnon Chain Corp. During World War II Stone served as deputy director of the Machine Tool Division and assistant director of the Equipment Bureau of the War Production Board. He will be one of four assistant administrators named to constitute an executive committee.

Pending absorption of administration of the CMP by the operating bureaus, Walter C. Skuce has been designated as assistant administrator for production controls to supervise its operational procedures.

The realignment will not affect other branches of NPA such as the facilities, construction, and policy-coordination bureaus and the offices of small business, civilian requirements, and field service.

Defense Orders

WASHINGTON.—The following orders have been issued by the defense agencies:

Petroleum Administration for Defense

Interior Delegation No. 1, April 17: Delegating authority over certain petroleum-base chemicals to the National Production Authority.

Office of Price Stabilization

Amendment 1 to General Ceiling Price Supplementary Regulation 15, April 18: Exempting contracts and fees charged by professional oil and gas-well drillers and firefighters from price control.

National Production Authority

Amendment to Regulation 3, April 16: Extending MRO and priority privileges to Canadian companies.

Order M-57, April 16: Limiting the use of quebracho in the drilling of oil and gas wells.

Amendment to Regulation 4, April 16: Prohibiting the use of DO-97 ratings to secure certain materials and products as MRO supplies.

Schedule 3 to Order M-46, April 18: Placing sulfuric acid under limited allocation.

Schedule 4 to Order M-45, April 20: Allocating plastic-type nylon.

Amendment to Order M-7, April 20: Reducing the allowable consumption of aluminum for consumer items from 65 per cent of average consumption during the first half of 1950 during April to 50 per cent during May and June.

Another development using

B. F. Goodrich Chemical Company ***raw materials***

drillers clean up two ways at once!

B.F.GoodrichChemical Company does not make this pipe wiper. We supply raw materials only.

Hycar rubber part molded by Murray Rubber Co., Houston, Texas.

Flex-Lip Pipe Wiper by Petroleum Mechanical Develop. Co., Houston, Texas.

BECAUSE drill pipe has to make many trips in and out of the hole, a pipe wiper is necessary. First, to clean slippery drilling mud from the pipe as it comes out of the hole... helping keep the derrick floor clean for workmen's safety. Second, wiping drilling mud from the pipe keeps costly drilling fluid *in* the hole where it belongs—prevents waste. Two savings at once!

It takes an out-of-the-ordinary material to make a successful pipe wiper. That's why Hycar rubber was chosen. For Hycar has top-notch resistance to oil, gas and abrasion. It won't deteriorate in contact with gas and oil contaminated drilling fluid.

What's more, Hycar stands up under severe wear and abrasion conditions. For example, when pulling pipe through the wiper, the body of the wiper is held against the bottom of the rotary table. When the pipe is spun to unscrew a joint, the wiper body spins right with the pipe. Here again, Hycar comes through a winner —withstands terrific punishment.

Hycar has many uses in oil field machinery and equipment. It resists oil, gas, heat, weather and wear—has many more advantages. It may help you develop or improve a product. At present, demand for Hycar exceeds supply. However, limited quantities are available for development work. For technical bulletins and advice, write Dept. HF-5, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco.

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Expansion Plans

Washington estimates industry will spend 1.5 to 2 billion dollars to meet defense needs, increasing civilian demands

WASHINGTON. — Expansion plans of the oil industry may involve expenditures between $1,500,000,000 and $2,000,000,000 to meet the needs of the defense program and growing civilian demand, according to estimates made in various Washington quarters.

Already the industry has received certificates of necessity for the quick amortization of more than 50 projects, which it is estimated will cost $370,000,000, and that covers only part of the applications received. In addition, other projects are being planned on the basis of constantly improving information as to what production will be required in the future.

Breakdown.—Expansions in the refining industry are expected to cost as much as $750,000,000 to $1,000,000,000. Approximately $1,000,000,000 more is expected to be expended in expanding production and marketing facilities.

Not all new plants and equipment will be covered by amortization certificates. Certificates are issued on the basis of the contribution the facilities will make to production for the defense program and defense-supporting industries, and not all projects can qualify.

In normal times, it is difficult to make more than an educated guess at what industry is going to spend on expansion, the most reliable figures being those prepared by corporations for financing purposes; unincorporated concerns and individuals are under no compulsion to make their expansion plans public. From now on, it will be possible for the government to make more complete estimates because of the necessity for filing for certificates of necessity, for securing authority to construct new buildings, use material, and secure equipment.

Business and industry. — A recent Commerce Department and Securities and Exchange Commission survey indicates that business and industrial-expansion outlay this year will amount to approximately $24,000,000,000, an increase of about 29 per cent over the $18,560,000,000 estimated to have been spent in 1950.

Whether this figure will be reached will depend, in part, on the availability of materials and manpower. Many expansion programs of nonessential industries may have to be shelved for the duration of controls. Some construction projects on that order already have been turned down by the National Production Authority.

One additional factor must be kept in mind in attempting to translate expenditures into productive capacity. The dollar today will buy much less than it did during the war when the oil industry poured huge sums into new facilities, and even less than it would in 1950.

Petrochem Controls

WASHINGTON.—The division of authority between the National Production Authority and the Petroleum Administration for Defense has been clarified by Interior Delegation No. 1 which has turned over to NPA certain responsibility for a number of petrochemicals. Most of these, it was pointed out, are produced by other industries as well as the oil and gas industry.

Under the delegation, NPA is given authority over both the production and distribution of carbon black (including channel and furnace black), ammonia, butyl rubber, S and N type rubbers, and polybutadiene rubbers.

NPA is also given authority over the distribution, but not the production, of polymers of isobutylene having a molecular weight of 10,000 and higher and free of other substances; naphthenic acid and copper and other metallic naphthenates; chemical grade aromatics except mixed cuts used for fuels or solvents; benzene, toluene, xylene, ethyl benzene, styrene and other purified aromatics; oxygenated compounds such as alcohols, aldehydes, ketones and organic acids; phenols and phenolic compounds; insecticides, fungicides and herbicides; white oil petroleum and other oils used for medicinal, pharmaceutical, and cosmetic purposes; special waxes and polishes, exclusive of paraffin waxes or microcrystalline waxes; detergents other than sulfonates, and plastics such as polythene.

PAD Gas Appointment

WASHINGTON.—Louis C. Sonnen of Houston, vice president in charge of purchasing for the Tennessee Gas Transmission Co., has been appointed director of the gas-facilities division of the Petroleum Administration for Defense.

The division will be responsible for all matters connected with facilities necessary for the transmission of gas, as well as special analyses of critical materials required, engineering consideration of gas-industry projects, and expediting of gas projects essential to the defense-production program.

WEST COAST

Drilling Activity

California operators plan second-quarter increase

LOS ANGELES.—While the actual number of completions will be affected by the availability of tubular goods, California operators plan a further increase in drilling activity during the second quarter.

The quarterly forecast prepared by the conservation committee showed operators planned to drill 366 field wells during the first quarter, almost 90 more than in the like period of 1950.

Forecast. — The committee's forecast for this quarter shows that operators anticipate completing 154 field wells this month, 163 in May, and 139 in June. This would be about 150 more than the number planned at this time a year ago. If steel is available, the number drilled in June probably will be higher than the 139 forecast, due to forced offsets and developments taking place after the drilling programs were planned.

In San Joaquin Valley, where about 50 per cent of the drilling is planned, South Belridge is slated to receive most activity. A total of 36 wells are scheduled to be completed there. South Cuyama has 15 wells planned, Edison 19, Fruitvale 13 during April and May, and Midwest-Sunset has 13.

Coastal region.—In the coastal region, West Cat Canyon is expected to have about six completions monthly and Ventura Avenue about the same. Wilmington field in the Los Angeles basin is scheduled to remain the state's most active field. Monthly completions there are slated to average about 17.

Elk Hills Bidding Heavy

LOS ANGELES.—Changed conditions in the California crude-oil situation was reflected in the recent bidding for oil to be produced from the shallow and Stevens zones at Elk Hills Naval Reserve. A year ago when the Navy offered its oil for sale there were no bidders. This month when the Navy called for bids there were five takers.

Bidders for shallow-zone crude were Standard of California, Wilshire Oil Co., and Westoil Terminals. Standard and Wilshire bid the posted price, but Westoil offered a 1-cent premium provided its offer for buying Stevens-zone crude also was accepted. In addition to these three companies, Caminol Co. and Sunset Oil Co. bid on Stevens crude. Standard bid the

posted price, but the others offered a 5-cent premium.

About 5,000 bbl. daily of shallow-zone crude was involved in the bidding, and about 65 bbl. daily of Stevens-zone oil. The Navy, now studying the bids, will announce the successful bidder in about 45 days.

Big Suits

Royalty owners charge antitrust-law violation

LOS ANGELES.—Two suits asking damages of $2,800,000 have been filed in California courts against oil companies and the California Conservation Committee.

One suit, filed in federal court and asking $2,400,000, appears to be the first in which private litigants have invoked antitrust laws in claiming damages incurred through unit operation of oil properties.

Both suits are concerned with operation of the 60-acre Grimes lease, a year-old unit operation in Coalinga Nose field.

The second suit, filed in the superior court at Fresno, asks $400,000 damages. Defendants are Los Nietos Co., Seaboard Oil Co., Honolulu Oil Corp., and McAlester California Oil Co.

In this suit Edgar G. Grimes, Walter Hintz, Southwestern Development Co., and other royalty owners charge that through failure to develop fully and operate the 160-acre lease, 200,000 bbl. of oil has been taken by the defendants from the Grimes lease through wells on contingent properties.

Only two wells have been drilled on the Grimes lease and these have been shut in for the past 10 years. The royalty owners claim that the $2,400 which they have been receiving monthly during the 10-year period did not cover royalty payments on the 200,000 bbl. allegedly removed through wells on the adjacent properties, but was only a recompense for failure of the defendants to fulfill the development contract.

In the other suit the same royalty owners ask $2,400,000 for damages resulting from an alleged conspiracy between the California Conservation Committee and seven oil companies to violate the antitrust laws by curtailing oil production in California and completely stopping production from the Grimes lease in order that the oil could be produced through wells on adjacent leases.

Defendant oil companies are Standard Oil Co. of California, Superior Oil Co., The Texas Co., Union Oil Co., Richfield Oil Corp., Shell Oil Co., Tide Water Associated Oil Co., and the defendants of the $400,000 suit.

The lease involved is located on the highest part of the Coalinga Nose structure, in what is now a gas-cap area. Discovery well for the Gatchell zone was completed there in July 1938 and the second well drilled shortly after.

By the end of 1942, 166 wells had been completed in the remainder of the field on a density of one well per 19 acres. No other development took place on the Grimes lease. The two existing wells were closed in during March or April 1941 and have been kept closed ever since.

The complaining royaly owners included the conservation committee as a defendant by alleging it was used as an instrumentality in bringing about the taking of oil from the Grimes lease.

They ask the court to order the oil companies to divest themselves of their interest in the lease to a company which will agree to produce the wells on a competitive basis with other Coalinga field leases.

They also complain that the method of allocating production under unit operation does not give them a fair share and that they were not consulted in the formation of the unit.

SOUTHWEST

How to Get More Oil

Increased recovery from limestone is subject of Texas conference; tests using seven new techniques described

Leigh S. McCaslin, Jr.

COLLEGE STATION, Tex.—The use of such diverse substances as bacteria and carbon dioxide for increasing the recovery of crude oil were discussed last week at the second Oil Recovery Conference of the Texas Petroleum Research Committee.

Four hundred engineers and operators gathered on the Texas A. & M. College campus to hear 16 papers on the general theme of limestone reservoirs.

Railroad Commissioner William J. Murray, Jr., opened the meeting with a challenge to the group to find ways of increasing recovery from the tremendous limestone reservoirs in Scurry County and in the Spraberry trend of West Texas. He said the Scurry reef and Spraberry fields together have reserves equal to one-half the nation's total estimated ultimate recovery of crude oil.

George H. Fancher, director of the committee, reported that the group's survey of secondary-recovery possibilities of Texas oil fields is one-third to one-half completed. He added that T.P.R.C. has prepared 13 publications to date and has graduate students working on fundamental research at both A. & M. and Texas University.

Limestone's origin. — Paul Weaver, chief geophysicist of Gulf Oil Corp., as conference banquet speaker provided excellent background for the 16 detailed technical papers with his discussion of "Carbonate Rocks," a general classification including limestone.

Answering questions on how porosity of these rocks was formed and whether the oil originated in the rocks, Weaver said:

"Carbonate rocks can be formed on shallow shelf areas—(1) from seawater, (2) from older limestones on the shore of the shelf, and (3) from bones and shells of marine organisms. Original deposition is in discrete particles, crystalline or fragmental in form, which have partings between. These partings are preserved as one kind of pore system when the rock hardens. When the rock is raised even a little above sea level, solution and borings by organisms make larger pores, which also are maintained as the surface is again covered by sea water, to become a second type of porosity.

"Finally, this formation of the carbonates can in some degree cover and preserve organic matter from the sea as a source for future oil."

New recovery methods.—Seven methods for increasing the recovery of oil were covered in an extensive paper by Paul D. Torrey, Lynes, Inc., Houston, at the opening session. He said that all are being applied at present in small-scale field tests. They include:

1. The Atlantic Refining Co. high-pressure gas-injection process. Improvement in ultimate oil recovery has been indicated by a pilot field test currently in progress in Crane County, Texas. This test is regarded as being so successful that a large-scale operation will soon be undertaken.

2. The injection of inert gases, which is being carried on in Kansas and Wyoming, but which has not progressed sufficiently to provide dependable quantitative data.

3. The application of heat to reservoirs, particularly with reference to the underground gasification of coal.

4. The extraction of oil by solvents, which appears to be feasible where hydrocarbon solvents can be used and where it is not necessary to separate completely the solvents from the crude oil in the field.

5. The combined injection of gas and water, which in Bradford field indicates may result in an improve-

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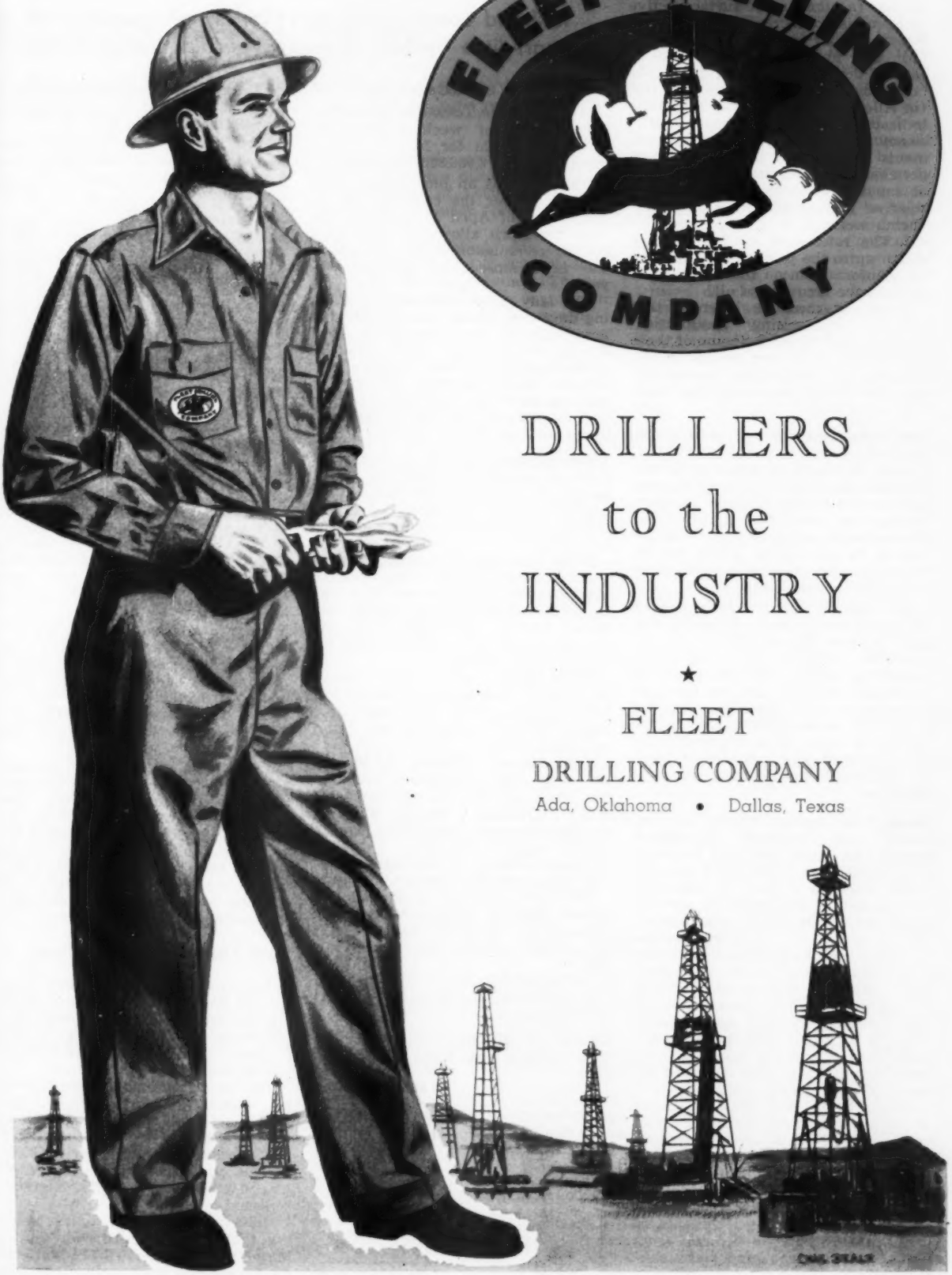

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ment in recovery of from 10 to 15 per cent.

6. Chemical flooding, which includes: (a) the use of surface active compounds to increase injective capacity and to increase oil recovery; (b) the important application of carbon dioxide, which in numerous laboratory tests and in one field test (in Allegany County, New York) has indicated a notable increase in efficiency in oil recovery; and (c) treatments designed to increase relative permeability to water in the reservoir at input wells and to increase the relative permeability to oil at producing wells.

7. The release of oil by bacteria, which up to the present has provided more information on the origin of oil than on the recovery of oil.

Torrey warned his listeners that although "promising possibilities" have been indicated for some of these techniques, it is impossible at the present time "to evaluate completely their future application or their relative importance."

Heat treatment.—With regard to the application of heat to reservoirs, Torrey discussed in some detail the proposal made by Frederick Squires, Illinois Geological Survey Division. Squires has noted that many of the oil-producing areas of the U. S. are located in coal basins where the oil reservoir rocks are in reasonable close proximity to coal beds.

He suggests that hot gases can be produced underground from the coal and injected directly into the oil reservoirs without first bringing the gas to the surface. The oil would be vaporized in large part by the high temperature, and would move to the producing wells and thence to the surface in vapor phase where it could be recovered and partially refined by fractional condensation as it is produced.

South Penn report.—Torrey also released some hitherto unpublished material on results obtained by South Penn Oil Co. in a combined gas and water injection project. On one project located in the southern part of the Bradford field, gas was injected over a period of 3 months into the oil sand after water had been injected for several years. Thereafter water injection was resumed in the normal manner. It has been estimated that oil recovery will be increased from 10 to 15 per cent by the combined water and gas injection over what would have been obtained by conventional flooding alone.

A brief report was given by Torrey on the use of a group of surface active compounds (consisting of ethylene oxide condensations of fatty amines) developed by Armour & Co. for use with water injection operations. In a current field test their use, according to Torrey, has increased the rate of underground fluid movement from input wells to producing wells substantially.

Record Allowable

Railroad Commission orders fifth straight increase this year; little further increase expected before winter

Leigh S. McCaslin, Jr.

AUSTIN.—The Texas Railroad Commission last week boosted the state's allowable for May to a new record high of 2,936,323 bbl. daily.

The figure is an increase of 10,741 bbl. daily over the calendar-day allowable as of April 14, is 57,773 bbl. over the April allowable established by the commission in March, and is the fifth consecutive increase this year.

The May order calls for 24 producing days throughout the general state area with 19 days allotted to East Texas. Nelson Jones of Humble Oil & Refining Co., Houston, recommended the above schedule, and H. P. Nichols, executive vice president of the East Texas Oil Association, favored the East Texas rate.

Little comment.—Of the five oil company representatives testifying at the hearing, two reported difficulty in obtaining desired quantities of crude, but the total only amounted to 8,000 bbl. daily.

Little was said at the short (16 minute) proration hearing which preceded the issuance of the order, but the undertones indicated the feeling that Texas flow is sufficiently high and should be kept at the current rate for the next few months.

There were some off-the-record sentiments expressed to the effect that the allowables may even drop slightly before rising with the winter demand.

Commissioner William J. Murray stated the Bureau of Mines report for the week of April 7 was confusing when it showed a storage decrease despite increased production and a decline in refinery runs. However, it appears there is a natural statistical lag in compiling returns, he said.

The May allowable is 436,323 bbl. higher than the bureau's forecast of demand for Texas oil and is 33,111 bbl. above purchase nominations for May.

Estimated distillate and natural-gasoline production amounts to 365,000 bbl. per day.

Change by district.—The May order with changes from April 14 is as follows:

District—	May	Change
1. Southwest	37,660	+ 129
2. Gulf Coast	172,636	+ 1,528
3. Gulf Coast	510,598	+ 3,449
4. Southwest	271,036	+ 1,857
5. East Central	54,218	+ 465
6. Outside E. T.	119,016	+ 958
East Texas	273,967	— 8,618
7b. West Central	102,774	+ 602
7c. West	99,029	+ 705
8. West	994,509	+ 8,693
9. North	194,150	+ 971
10. Panhandle	106,730	+ 2
Totals	2,936,323	+10,741

The next state-wide proration hearing of the Railroad Commission will be held in Austin on May 17.

How the new May allowable compares with those of 1950 and the first 4 months of 1951 is shown in the following table:

1950	
January	2,050,948
February	2,052,174
March	1,944,122
April	2,088,722
May	2,179,586
June	2,366,376
July	2,445,935
August	2,580,328
September	2,823,720
October	2,761,296
November	2,722,705
December	2,556,944
1951	
January	2,698,607
February	2,758,953
March	2,800,742
April	2,878,550
May	2,936,323

Tax Bills Pass House

AUSTIN.—Two tax bills affecting the oil and gas industries have been passed by the house and now await action in the senate of the Texas Legislature.

The Sewall natural-gas tax bill would levy a tax of 1 cent per thousand cubic feet on the gathering of natural gas. The omnibus bill would make permanent a 10 per cent increase on 25 natural resources, with oil and gas providing the major part of the revenue.

The senate, meanwhile, is awaiting a revised estimate of prospective revenue from the state comptroller. Gov. Allen Shivers last week said the tax picture is "much brighter than it was at the beginning of the session," and that he feels the omnibus bill plus a small increase in natural-gas and gasoline taxes will meet Texas' revenue needs for the next 2 years.

East Texas Pressure Rises

AUSTIN.—The bottom-hole pressure of East Texas oil wells is slowly rising although the wells are producing more crude, according to Olin Culberson, chairman of the Railroad Commission.

The average pressure increased 0.21 psi. during March to 1,019.85 psi., Culberson said. With allowables up above 8,000,000 bbl. for the month, the pressure increase per 1,000,000 bbl. of oil withdrawn during March was 0,02473 psi., the commissioner reported.

Culberson presented figures showing that salt-water injection during March had declined by 8,494 bbl. from the 417,418 bbl. used during February.

Record Production

Most world areas producing at maximum rate; Middle East helps boost February daily output to 11,382,000 bbl.

Dahl M. Duff

WORLD crude-oil production rose approximately 100,000 bbl. daily in February, principally as a result of increased output in Saudi Arabia and Iran.

The 0.9 per cent gain over the previous month lifted the February total to a daily average of 11,382,000 bbl. and established another new record. World crude output dropped 0.7 per cent from November to December, increased 0.8 per cent in January, and continued this upward trend in February.

Gains general.—Only minor gains were shown in February in production in the United States and Venezuela. United States output was estimated at 5,923,000 bbl. daily, a new record, but only slightly more than 16,000 bbl. daily over the January total. Venezuelan output showed the slight increase of 1,600 bbl. daily to surpass the January record of 1,634,400 bbl. daily.

Foreign production, exclusive of Russia, gained about 85,000 bbl. daily, or 1.9 per cent, in February. This accounted for most of the increase in the world total during the month.

World production in February was 1,875,000 bbl. daily greater than the production of February 1950. This represents a gain of 19.7 per cent. United States production in February was 19.2 per cent above that of the year-earlier month.

Speculation.—The prospective nationalization of the oil industry in Iran has caused speculation in industry circles in recent weeks over the possible effect of the loss of the major Iran production on other producing areas. There has been some buying of Venezuelan oil stocks in New York on the theory that the development in Iran would lead to expansion of output in Venezuela.

With most of the world's oil areas producing at or near maximum, it does not appear there would be any prospect of making up immediately a loss of 700,000 bbl. daily—as remote a possibility as this seems to be at the present time. If Iranian oil were suddenly lost to the non-Communist world, it would be a year or more before it could be replaced by intensive development in such countries as Kuwait, Saudi Arabia, Iraq, and Qatar. Venezuelan production would be called on to help meet the initial deficit, but the principal replacement in the long run would be from the other countries of the Middle East.

Venezuelan increase.—The expansion in Venezuelan production over the last year and likelihood of continued good markets has given an optimistic outlook for the industry in this country.

Dr. Therry Fombona, hydrocarbons

WORLD CRUDE-OIL PRODUCTION
(Thousands of barrels daily)

Country—	Feb. 1951	Jan. 1951	Feb. 1950
Western Hemisphere:			
Argentina	67.0	65.0	62.0
Bolivia	1.5	1.6	1.7
Brazil	1.2	1.2	0.5
Canada	94.1	91.0	68.7
Chile	1.7	1.7	1.9
Colombia	108.4	101.3	80.4
Cuba	0.3	0.3	0.4
Ecuador	7.5	7.5	7.1
Mexico	204.0	207.0	187.8
Peru	42.4	42.4	41.0
Trinidad	56.5	57.5	57.0
Venezuela	1,636.0	1,634.4	1,318.8
Total	2,220.6	2,210.9	1,827.3
Europe and Africa:			
France	4.8	4.1	1.2
French Morocco	0.9	0.9	0.8
Germany	24.0	23.1	20.4
Italy	0.1	0.1	0.2
Netherlands	14.0	12.3	15.2
Egypt	45.5	46.0	43.8
United Kingdom	0.9	0.9	0.9
Total	90.2	87.4	82.5
Middle East:			
Bahrein	30.6	30.1	30.3
Iran	704.6	647.8	629.8
Iraq	170.5	168.6	114.5
Kuwait	358.8	422.0	268.3
Qatar	48.0	44.1	26.6
Saudi Arabia	633.7	561.2	496.4
Turkey	0.4	0.4	0.6
Total	1,946.6	1,874.2	1,566.5
Other Asia:			
British Borneo	100.0	100.0	68.7
Burma	2.0	2.0	0.5
China	2.2	2.2	1.5
India	5.0	5.0	5.5
Indonesia	155.0	155.0	122.2
Japan	5.6	5.8	5.2
New Guinea	4.8	4.8	4.6
Pakistan	3.7	3.6	2.5
Total	278.3	278.4	210.7
Total, foreign less Russia and E. Europe	4,535.7	4,450.9	3,687.0
Estimated Russia and Eastern Europe:			
Austria	27.0	27.0	22.0
Romania	82.0	82.0	82.0
Russia	790.0	790.0	730.0
Other E. Europe	24.1	24.1	19.0
Total	923.1	923.1	853.0
Total, foreign	5,458.8	5,374.0	4,540.0
United States	5,923.0	5,906.8	4,966.9
World total	11,381.8	11,280.8	9,506.9

Figures are from reliable reports in the industry or official government sources. Data for Russia and Eastern Europe are based on competent estimates; no authentic information is available on month-to-month production in these areas. Completely current reports also are lacking for certain areas of Southeast Asia.

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director, recently predicted Venezuelan production will reach 1,700,000 bbl. daily in coming months. Arthur Proudfit, Creole Petroleum Corp. president, said output is likely to average 1,700,000 bbl. daily for 1951, indicating a considerable higher production in the later months of the year. These predictions are based on engineering plans and agreements between the government and the producing companies. A third favorable forecast given recently was that of Dr. Aurelio Arreaza, finance minister, who said Venezuelan output possibly will reach 2,000,000 bbl. daily in the 1951-52 fiscal year.

Venezuelan production in weeks during February was: week ended February 5, 1,638,300 bbl. daily; February 12, 1,629,700 bbl. daily; February 19, 1,635,800 bbl. daily; and February 26, 1,646,400 bbl. daily. In the week ended February 19, Creole's operated production reached a new all-time high. In the same week Shell produced 545,499 bbl. daily with the Shell-owned production of 515,208 bbl. daily representing a record for the company to that date.

Government figures showed the following production by companies during January and February (figures represent leasehold production not corresponding in the case of the larger companies to operated production, or net plus purchased royalty):

	February	January
Creole	751,502	751,659
Shell	509,723	504,804
Mene Grande	223,008	224,240
Socony-Vacuum	45,171	46,780
Texas	25,330	25,627
Mercedes	22,221	21,588
Atlantic	20,350	19,933
Sinclair	11,309	11,263
Pantepec	10,408	10,793
Richmond	10,278	10,447
Phillips	5,693	6,347
B.C.O.	968	914

Colombian crude production in February was also at a new high with 108,400 bbl. daily, exclusive of condensate. Production by concessions during the month was: De Mares 39,633 bbl. daily, Barco 29,584 bbl. daily, Yondo 34,220 bbl. daily, Dificil 2,299 bbl. daily, Cantagallo 1,201 bbl. daily and Velasquez (Teran-Guaguaqui) 1,423 bbl. daily.

Chilean crude production from the Straits of Magellan fields continues at about 1,700 bbl. daily. Plans of the Chilean Government oil organization call for maintaining this rate, the minimum under its contract with Uruguay, at least through 1951 pending construction of the new gasoline-extraction and stabilization plant. About half of the current output is coming from the new Cerro Sombrero field.

Europe.—In Europe the small indigenous French production continued to rise as a result of the development of Lacq field in southwestern France. The Aquitaine company, Lacq operator, announced in Paris that output of the field in February rose to 14,982 tons, compared with 13,524 tons in January. The remainder of France's output comes from the old Pechelbronn field.

TREND OVER LAST YEAR

1950—	Western Hemisphere less U. S.	Middle East	Total foreign less Russia and E. Europe
March	1,900.4	1,607.4	3,812.9
April	1,968.2	1,639.5	3,918.2
May	1,775.4	1,752.0	3,847.4
June	2,098.2	1,811.5	4,229.6
July	2,073.2	1,808.3	4,202.6
August	2,097.8	1,839.5	4,273.6
September	2,146.1	1,803.7	4,297.1
October	2,185.7	1,893.2	4,428.9
November	2,213.8	1,899.1	4,474.1
December	2,213.6	1,988.9	4,563.0
1951			
January	2,210.9	1,874.2	4,450.9
February	2,220.6	1,946.6	4,535.7

Crude production in Germany in February on a daily average basis gained slightly over January to a new high. February output was 94,685 tons, including 41,749 tons in the Emsland, 42,984 tons in the rest of lower Saxony, 9,469 tons in Schleswig-Holstein and Hamburg, and 483 tons in Baden.

Middle East.—Production in the Middle East in February gained some 3.9 per cent, or about 72,000 bbl. daily, over January, but was still below the record high level of 1,989,000 bbl. daily reached in December. The most significant change among the individual countries in this area during February was the sharp drop shown in Kuwait which was down about 63,000 bbl. daily from its 422,000-bbl. daily record production in January.

Increased output in Iran and Saudi Arabia, however, offset the decline in Kuwait. Saudi Arabian production was up 72,500 bbl. daily, and that in Iran, 56,800 bbl. daily. The drop in Kuwait's production was attributed to variations in tanker nominations.

Russia.—The Moscow radio in a recent summary of economic achievement of the Soviet state confirmed that Russian crude-oil production last year was some 37,500,000 tons (equivalent to about 754,000 bbl. daily). Production in the region from the Volga River eastward totaled about 16,000,000 tons in 1950 against 3,700,000 tons in 1940. Production in the Baku and other western areas amounted to 21,400,000 tons in 1950 as compared to 27,300,000 tons in 1940.

MIDDLE EAST

Iranian Crisis

Abadan refinery strike hits Eastern Hemisphere products supplies; PAD, companies discuss ways to combat shortage

OIL companies operating abroad took steps this week to counteract products shortages threatening in many foreign areas, as a result of the continued near shutdown of the 500,000-bbl. daily Abadan refinery of Anglo-Iranian Oil Co., Ltd.

Representatives of the affected companies last week entered the market for all types of products from the Gulf and West Coast and Caribbean area. Reports in New York were that some 40 cargoes had been obtained, and that all stocks available on the market would be taken.

Through last week the Abadan plant operated at an average of about 130,000 bbl. daily when only about 2,600 of its normal complement of some 9,000 workers reported for duty in the face of strike violence which first began shortly after the Iranian Parliament's decision to nationalize the British-owned oil industry.

The loss of products from Abadan, amounting to more than 400,000 bbl. daily, about 40 per cent of which is fuel oil, has been felt quickly throughout the Eastern Hemisphere. Unconfirmed reports indicated some chance for resumption of full operations at the refinery, but even if this happens, the over-all situation is expected to worsen because of the lack of tanker deliveries over the next few weeks.

One country affected immediately was India, where kerosine stocks were reported nearly exhausted. Throughout the Eastern Hemisphere, ships' bunkers, particularly at such points as Aden, were running critically low. Some oil companies were reportedly requiring vessels to the Mediterranean area and Europe to carry fuel for the return voyage—even at loss of cargo.

Officials of the Petroleum Administration for Defense were conferring with company officials in Washington on the situation. There was hope that PAD will assume the role of coordinator by suggesting refinery yields and deliveries, and taking other means to enable companies to meet the situation. Even if Abadan goes back on stream, in the near future and the emergency is met, there is a feeling that long-term arrangements to substitute for its production should be worked out in view of the internal conditions in Iran which one source said were beginning to come close to civil war.

The world-wide Royal Dutch-Shell organization, Standard - Vacuum Oil Co. in the Far East, and Anglo-Iranian itself were the companies most severely affected by the Abadan shut-

down. Standard-Vacuum draws heavily on Abadan for some of its requirements, while Shell has joint-marketing arrangements and exchanges with Anglo-Iranian in many parts of the world.

Anglo-American Renamed

Anglo-American Oil Co., Ltd., British affiliate of Standard Oil Co. (N. J.), has announced in London that it is changing its name to Esso Petroleum Co.

The action is in line with Jersey Standard's policy of simplifying names of its foreign affiliates under the Esso designation. Anglo-American is one of the principal importing, refining, and marketing companies in the United Kingdom. Its Fawley refinery, due to be opened this summer with a 126,000-bbl. daily capacity, will be the largest in Europe.

FAR EAST

Lubes for Japan

Marifu refinery expansion may be completed this year

FACILITIES to produce lubricating oils and other improvements are in the construction or design stage at the Marifu refinery of Koa Oil Co., Ltd., in Japan.

The Marifu refinery is one of the group of Japanese Pacific Coast plants using imported crude which were reconstructed after occupation authorities authorized their resumption of operations in July 1949. The Koa company began an expansion program at the Marifu refinery after a capital tieup with Caltex Oil Products Co. on a 50-50 basis in November 1950.

During the current year, the company is planning to increase refined-oil and crude-storage capacity along with the addition of lubricating-oil facilities. A 3,000-bbl. daily vacuum unit and a 1,000-bbl. daily contact-rerun unit are being constructed by Tatsumi Engineering Co. with completion expected this summer.

Solvent-dewaxing and solvent-extraction plants are being designed. Construction of these units is expected to be completed the end of the year or early in 1952. Their completion will give the Koa company one of the most modern lubricating-oil plants in Japan.

At present, the Marifu refinery's 6,000-bbl. topping plant and 2,500-bbl. cracking plant are charging 3,000 bbl. daily, maximum permitted by government allocation. Throughput is expected to be increased to 4,000 bbl. daily beginning in April. Koa began refining at Marifu in 1943 and in the spring of 1945 installed a 7,500-bbl. catalytic cracking unit. During initial operation the cracking unit, but not the topping plant, was destroyed.

Rehabilitation at Marifu was aided by technical assistance from Caltex. Since the refinery was to process Arabian crude, J. C. Fifer, assistant superintendent at Ras Tanura, and various Caltex officials, A. J. Herron, R. A. Andresen, V. A. Raven, and A. Ritzenthaler, were sent to Japan to assist with the work. Herron recommended for the Marifu refinery an organization chart in line with American standards. Ritzenthaler is now in Japan continuing to give technical advice to the company.

LATIN AMERICA

Creole Output Up Slightly

Another relatively small increase in crude production was shown by Creole Petroleum Corp. in Venezuela during January.

The company's operated production reached 691,924 bbl. daily, 2,171 bbl. daily over December. Of the January total, 534,204 bbl. daily came from the Lake Maracaibo area, 3,407 bbl. daily from Cumarebo, and 154,313 bbl. daily from eastern Venezuela. Net production plus purchased royalty during January was 732,085 bbl. daily, also a slight increase over December.

Creole refined 130,667 bbl. daily at its two refineries during January, with 66,653 bbl. daily at Caripito and 64,014 bbl. daily at Amuay. During the month, an average of 8.2 rigs were operating, and 11 wells, 10 of them field wells, were completed. The one exploratory well was in Pedernales, with a depth of 7,041 ft. and an initial production of 224 bbl. daily.

Lube Plant for Mexico

Lubricating-oil manufacturing facilities will be installed soon at the Salamanca refinery of Petroleos Mexicanos, Mexican oil agency.

Construction contract for the facilities, to cost an estimated $11,250,000, has been awarded Arthur G. McKee & Co.

A Pemex announcement said the plant will supply high-quality lubricants, resulting in a large saving in dollars now used for imports.

EUROPE

French Plan Products System

Compagnie Petroles Francaises is preparing to build a 200-mile products system which will consist of a 10-in. line from Le Havre to Paris-France, and three laterals. Work will commence within 2 or 3 months.

Entrepose, an affiliate of Societe Francaise de Constructiones, will build the system with two spreads furnished principally with American equipment. Count Dominique de Clercq, from the French headquarters of Anglo American Mining Co., has been on a tour in the United States gathering information on methods and equipment.

U.K. Equipment Orders Gain

A gain of about 21 per cent occurred in the last quarter of 1950 in the value of orders placed for petroleum equipment in the United Kingdom by British oil companies for overseas use.

Orders rose from £9,600,000 in the third quarter to £11,600,000 in the fourth quarter. The figures show only orders in the U.K. from British companies in foreign operations and does not include the substantial orders placed in Britain by American companies for use in the Middle East and in European refinery construction.

Although the total of the British orders for 1950 cannot be determined exactly since the basis of compilation was changed at midyear, it is indicated to be roughly £44,200,000. This compares to the 1949 total of £63,000,000 which included a number of exceptionally large orders for the new refineries now under construction in Britain.

AFRICA

Egypt Considers Drilling

The Egyptian Government is presently considering developing the Wady el Feiran oil discovery made in January 1949 by a Standard Oil Co. (N. J.) affiliate before it withdrew from further exploration activity in the country.

Cairo reports said that no definite decision had been made by the government on how to develop the property but that one group was contending that the work should be carried out by the Egyptian Petroleum Co-operative Society.

Wady el Feiran, the oasis near which the discovery well was located, is about 100 miles south of Suez on the Sinai Peninsula. The Jersey affiliate, Standard Oil Co. of Egypt, made the discovery as the only definite success in an exploratory program which it commenced in 1937 and on which some $15,000,000 was spent.

In 1949, Standard of Egypt discontinued exploration in the country, largely as a result of unfavorable Egyptian oil legislation. Subsequently, the Ministry of Commerce and Industry took over by decree the 60 sq. miles covered by the company's prospecting license in accordance with Article 3 of the mining law.

The Wady el Feiran well initially produced about 9 bbl. an hour of 23°-25°-gravity crude through a ¼-in. choke from the interval 6,505-70 ft. The producing horizon was identified as sands in Globigerina marls of Miocene age.

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PERSONALS

Dean of Research

Weaver has spent 4 decades in oil search

PAUL WEAVER, whose wide experience as a geologist and geophysicist has taken him to Venezuela, Trinidad, Mexico, Germany, the Far East, and around the globe wherever the search for oil has been pursued, is a veteran of 41 years in the oil industry.

Gulf Oil Corp.'s chief geophysicist for the past 22 years, Weaver recently was named special assistant to the vice president of the firm. He has served as past president of the Society of Exploration Geophysicists, and the American Association of Petroleum Geologists.

He recently was appointed an honorary member of the Houston Geological Society. A portion of the text of the scroll presented to him by the society reads: "A scientist of superior talent and a scholar of amazing and world-wide knowledge, he came to work on the Gulf Coast at the time when exploration geophysics started to play a vital and spectacular role in the discovery of new oil fields. His great experience in both geology and applied geophysics, coupled with his activity and leadership, have been a guiding spirit and constant inspiration to his associates and to the oil fraternity around him."

Weaver has been selected to be editor of the new Salt Dome volume of the American Association of Petroleum Geologists which will be published this year.

After graduation from Columbia University in 1908, Weaver served for 2 years on the U. S. Coast and Geodetic Survey and the U. S. Geological Survey. He was a geologist for Bermudez Co. of Venezuela and a short time later for S. Pearson & Son, Ltd., and Mexican Eagle Oil Co., Ltd.

In 1926 he joined Gulf at Houston as geophysicist and 2 years later was appointed chief geophysicist of the company.

In addition to his interest in oil, Weaver has been especially interested in the utilization of water, particularly from underground sources, and has served on the special water committee of the Houston Geological Society, the Houston Chamber of Commerce, and the legislative drafting committee of the Texas Water Conservation Association.

Dr. Paul D. Foote, vice president of Gulf Oil Corp. in charge of research and development, has been presented the Outstanding Achievement Medal Award of the University of Minnesota. The honor is reserved for former students who have attained high eminence and distinction.

Eugene Maxwell, geologist in the Wichita, Kans., office of Lion Oil Co., has been transferred to the firm's new land and geological office at Amarillo, Tex., as district geologist. **Billy Clifton,** who recently joined Lion, will join Maxwell in Amarillo in the near future to act as assistant geologist.

A. C. Wright, East Texas division geologist for Shell Oil Co. at Tyler, Tex., has been assigned to the area exploration staff to supervise special studies in the exploration department. Wright, who has been with the firm for 30 years, first moved to Tyler in 1929, and for the last 14 years has served as division geologist there. **T. M. Gruner** has replaced Wright as East Texas division geologist. Gruner, who has been with Shell since 1941, has been assigned to the area exploration staff for the past 9 months. **W. L. Grossman,** Houston division geologist, will leave in June on a 6-month assignment at The Hague. During his absence his duties and responsibilities as division geologist will be handled by **L. O. Wiringa.** In the production department, **O. L. Odale** was transferred from Kilgore, Tex., to Houston to become area chief mechanical engineer, succeeding **W. S. Crake,** who was transferred to Kilgore as East Texas division manager, the position formerly held by Odale. **R. J. Dobson** has been appointed chief exploitation engineer at Houston. Dobson has just returned from an assignment at The Hague, prior to which he served on the Houston staff for 6 months. **Morris D. Thompson,** exploitation engineer in the Houston division, has been transferred to the Corpus Christi, Tex., division to assist the division exploitation engineer.

Edward G. Borrego has assumed his duties as general manager of Tropical Oil Co. in Bogota, Colombia. He succeeded **L. W. Wiedey,** who was transferred to the Toronto office of International Petroleum Co., Ltd., of which Tropical is a subsidiary. Borrego formerly was assistant manager of I.P.C.'s activities in Peru and prior to that had been associated with Sociedad Petrolifera Italiana, affiliate of Standard Oil Co. (N. J.).

Charles V. Walton, Stanolind Oil & Gas Co. geologist, has been transferred from Jackson, Miss., to Salt Lake City as area geologist.

Victor Hugo King, geologist for the Ecuadorian government in Quito for the past year and a half, has resigned from the firm and returned to the United States.

Milton F. Shaffer, formerly chief production engineer with Shamrock Oil & Gas Corp., has joined Continental Carbon Co. as manager of the gas division in the Amarillo, Tex., office.

D. W. Smith, district superintendent for Sohio Petroleum Co., has been transferred from Shreveport to Russell, Kans.

C. R. Pierce, production foreman for Union Oil Co. of California, has been transferred from Odessa to Andrews County, Texas.

C. J. Allen has been named assistant to the president of Sinclair Oil Corp. He will continue as vice president of Sinclair Refining Co. **L. M. Fuller** succeeds Allen as assistant treasurer of the firm.

Frank C. Osment, formerly district geologist at Shreveport, is the new division geologist for Stanolind Oil & Gas Co.'s Texas - Louisiana Gulf Coast division. He joined Stanolind in 1945 as a geologist at Shreveport and was appointed district geologist for the Southeast district in 1949. He succeeds **Russell A. Weingartner,** who was transferred to the firm's Tulsa general office as senior staff geologist.

R. M. Beatty, formerly chief geologist of American Republics Corp., has joined Tennessee Gas Transmission Co. at Houston as administrative assistant of the gas-supply department. **Ralph Coleman,** formerly assistant general manager of Mexican Independent Oil Co. in Mexico City, has been appointed production superintendent of gas supply. **Stewart Barclay,** formerly chief geologist for Mexican Independent, has been named chief geophysicist.

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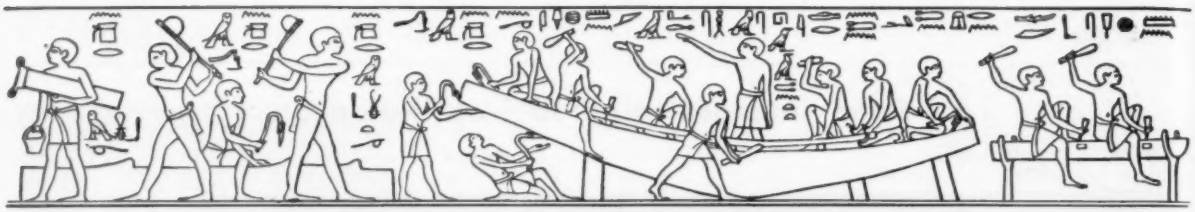

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Illustration at top, reproduced from "The History of All Nations," shows ancient Egyptian shipbuilding as depicted on the tomb of Ti, at Sakkara. In contrast is the 55' regenerator being built by Sun.

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PERSONALS

PAST PRESIDENTS.—Members of the Oklahoma City Geological Society gathered recently in Oklahoma City to commemorate the thirtieth anniversary of the founding of the organization. Past presidents of the society are shown above. Seated, left to right, are Dr. Irving Perrine, independent; Hubert E. Bale, consultant; J. T. Richards, Gulf Oil Corp.; William H. Atkinson, consultant; Jerry B. Newby, consultant; R. W. Laughlin, Laughlin-Simmons & Co., all of Oklahoma City; and Leland W. Jones, consultant, Edmond, Okla. Standing, left to right: Rizer Everett, Carter Oil Co., Oklahoma City; Dan O. Howard, Warren Petroleum Corp., Tulsa; Richard Camp, Consolidated Gas Utilities Corp., Oklahoma City; H. Travis Brown, Geolograph Co., Inc., Oklahoma City; I. Curtis Hicks, Phillips Petroleum Co., Ardmore, Okla.; E. G. Dahlgren, consultant, Oklahoma City; G. C. Maddox, Carter Oil Co., Oklahoma City; Harold J. Kleen, Kerr-McGee Oil Industries, Inc., Oklahoma City; E. A. Paschal, Coline Oil Corp., Amarillo, Tex.; and Dr. Robert R. Wheeler, Wheeler & Ingraham, Dallas.

W. C. Posey, tool pusher for Kemco Drilling Co., has been transferred from Enid to Blackwell, Okla.

Jack Martin, seismograph supervisor for General Geophysical Co., has been transferred from Casper, Wyo., to Houston.

A. I. Levorsen, former dean of the school of mineral sciences and professor of geology at Stanford University, is on leave of absence and has returned to Tulsa where he will be a consulting geologist.

Thomas D. Barber has been promoted to senior geologist in the Corpus Christi office of Stanolind Oil & Gas Co.

Gaston Stringer and **J. A. Richard,** both former tool pushers for Abbott-Traxler at Corpus Christi, Tex., have organized Stringer & Richard Drilling Co.

M. P. Swingle has been transferred from Shell Oil Co.'s Houston staff to Tulsa as supervisor of the production laboratory. **W. E. Schultz,** exploitation engineer at Elk City, Okla., has been transferred to Midland, Tex. **W. S. Lippitt,** subsurface geologist at Oklahoma City, has been transferred to Denver. **R. H. Miller,** production foreman at Elk City, has been transferred to Sterling, Colo. **L. E. Sharp,** division mechanical engineer in the North Texas division, has been transferred to the Houston area. **H. C. Slider** has been transferred to the Illinois division from Houston as a reservoir engineer. **G. C. Robinson** has been transferred to the Kansas division from Houston as mechanical engineer.

Samuel M. Gladney has been appointed assistant secretary of Sun Oil Co. **Samuel B. Eckert,** executive vice president, has retired.

Leslie Moses, division attorney for Midstates Oil Corp. at Shreveport, has resigned effective May 15, to accept a position with Crown Central Petroleum Corp. at Houston as executive assistant to the manager of the land, lease, and exploration department.

Francois Kermarrec, Jean Rochet, Jacques Schoeffler, Claude Joie, Michel Mangeon, Andre Rey, Robert Dolez, Bernard Leboucher, Louis LeGuern, Claude Richard, and **Francis Etienne Heritier,** a group of French engineers, will arrive at the University of Texas May 5 to commence a 9-month oil-indoctrination course.

J. W. Boone, exploitation engineer for Shell Oil Co., has been transferred from New Orleans to Houston. **J. B. Davis, Jr.,** mechanical engineer, has been transferred from Kilgore, Tex., to Tulsa. Other Shell transfers include: **G. H. Embry,** drilling foreman, from Eagle Lake to Premont, Tex.; **W. T. Nance,** mechanical engineer, from Kilgore to Houston as development engineer; **R. A. Tappmeyer,** mechanical engineer, from Houston to Kilgore; and **J. D. Thompson,** gas engineer, from Houston to Provident City, Tex. **H. R. Thompson,** exploitation engineer at Kilgore, has been promoted to division production geologist.

Charles H. Andrus, of San Antonio, and **Lee Roy Fuson,** of Three Rivers, Tex., have formed a partnership which will be known as Andrus & Fuson Drilling Co. Offices for the firm have not yet been established.

Duncan Corbett has resigned as assistant division engineer for Humble Oil & Refining Co.'s Corpus Christi, Tex., division, to join Hawn Brothers, independent operators.

R. G. Northrup has been elected president of the newly organized Field Drilling Co., at San Antonio, Tex. **Field M. Davis** is vice president, and **W. Earl Rowe** is secretary and treasurer.

Ray Ryan, R. S. Hays, and **E. G. Burke, Jr.,** have organized Mesquite Oil & Gas Co. of San Antonio.

Arnold O. Morgan, Corpus Christi, Tex., independent operator, has consolidated all his oil and drilling interests for operation under his own name. In the past, Morgan ran his varied interests under Patricio Oil Co., West Sinton Co., and Papalote Drilling Co.

D. T. Staples, executive vice president and a director of Pacific Western Oil Corp., was elected president of Oil Producers Agency of California at the meeting of the board of directors in Los Angeles. All other officers and directors were reelected.

Leonard J. Larguier, geophysicist at Oklahoma City for Standard Oil Co. of Ohio, has been transferred to Cas-

PERSONALS

ROCKY MOUNTAIN OFFICERS.—New officers of the Rocky Mountain District of the A.P.I.'s Division Production are shown here following their election at the annual meeting of the group in Casper. Left to right are Fred Clement, Continental Oil Co., Denver, vice chairman for Colorado; James A. Hill, Oil Well Supply Co., Casper, secretary-treasurer; Paul Kartzke, Shell Oil Co., Casper, vice president at large; C. L. Larson, Stanolind Oil & Gas Co., Casper, chairman of the advisory committee and retiring district chairman; and A. E. Campbell, Seaboard Oil Co., Casper, vice chairman for Wyoming. Not shown are C. H. Griffin, Phillips Petroleum Co., Casper, newly elected chairman; and H. F. King, Continental Oil Co., Billings, vice chairman for Montana.

per, Wyo., as area geophysicist. **Jack H. Walters,** district engineer at Houston, has been transferred to Lafayette, La., as district foreman.

A. B. Dooley, chief petroleum engineer for Belridge Oil Co., Los Angeles, recently resigned to open a consulting office in Bakersfield, Calif. He had been with Belridge for 20 years.

Larry Shomaker was elected president of the Midwest Gas Association at the forty-sixth annual convention held in Omaha, Neb. **Amos Abbott,** of Northern States Power Co., was named first vice president, and **E. E. Baxter,** of Central Electric & Gas Co., was made second vice president. **H. E. Peckham,** Northern States Power Co., was reelected secretary-treasurer.

Leonard F. McCollum, president of Continental Oil Co., has been named by **Gen. Dwight D. Eisenhower** to a national policy board of the newly formed American assembly set up to "clarify issues important to the American people."

Gus S. Wortham, of Houston, was elected member of board of directors of Texas Eastern Transmission Corp. to succeed the late E. Holly Poe of New York. All other members of the board was reelected. Wortham has been prominent in the Southwest as president and director of American General Life Insurance Co. of Houston.

D. Van Den Burg has been promoted from special assignments in production to general production superintendent for Shell Caribbean Petroleum Co. in Maracaibo, Venezuela. He replaces **R. N. Posgate,** who is now located in the United States.

Maj. Gen. Harry H. Johnson, of Houston, former codirector of the U. S.-Mexican Aftosa Commission, will assume the presidency of Algonquin Gas Transmission Corp. May 1.

G. O. Worley, assistant general superintendent for Rocky Mountain Drilling Co., has been transferred from Bakersfield to Ventura, Calif., in the same capacity.

D. E. Boone, formerly in the geological department of Ashland Oil & Refining Co., has joined **Scott Hammonds,** oil producer at Dallas, as chief geologist.

Lloyd C. Miller, until recently with American Independent Oil Co., Mexico City, has accepted a position as chief engineer in the foreign division of Signal Oil & Gas Co., Los Angeles.

C. L. Nance, formerly of San Diego, Calif., has moved to Evansville, Ind., to join his father, **Earl Nance,** in Acme Drilling Co.

D. L. Hussey, process superintendent on loan to Lago Oil & Transport Co., Ltd., from Esso Standard Oil Co. since December 1949, has been promoted to assistant general superintendent at the Bayway, N. J., refinery. **J. M. Whiteley** has been appointed process superintendent. **J. Chippendale** replaced Whiteley as technical superintendent and **F. W. Switzer** was promoted to the position of mechanical superintendent. **C. J. Griffin** was transferred to Belot, Cuba, as refinery superintendent. **G. L. MacNutt** replaced him as division superintendent (eastern) in the process department. **T. V. Malcolm** replaced Switzer as division superintendent in the mechanical department.

R. G. Yocom, formerly with Wasson & Co. at Evansville, Ind., is now an independent operator.

Mark Barry, of Gulf Oil Corp.'s New York office, is on a trip to Venezuela to study Mene Grande Oil Co., C.A.'s operations. He will spend some time in both eastern and western Venezuela.

D. M. Pinnell, Jr., has been appointed general field superintendent for Union Pacific Railroad Co. at Los Angeles, according to **William Reinhardt,** vice president of oil development.

F. E. Brown, assistant construction superintendent at Pan-Am Southern Corp.'s Alabama division, was transferred to Little Rock, Ark., and promoted to office manager.

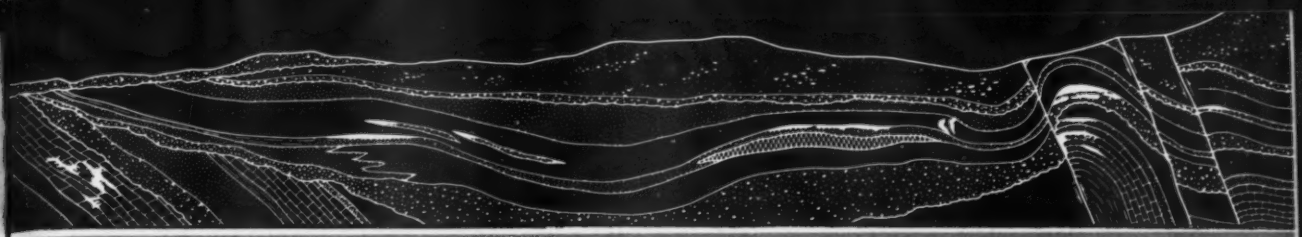
Harold Wilkinson, president of Asiatic Petroleum Corp. and Shell Caribbean Petroleum Co., has been presented the Medal of Freedom with Bronze Palm for his outstanding services in connection with the allied war effort from 1941-45. Wilkinson was the official petroleum representative for the British Government in Washington and served as petroleum adviser to the British joint-staff mission.

Dr. J. W. Bertetti has been named assistant general manager of manufacturing for Pan-Am Southern Corp. **E. N. Kimes,** superintendent of the El Dorado, Ark., refinery for about a quarter of a century, has been named refinery manager. Other changes are: **H. K. Wheeler,** from technical manager to assistant manager-technical; **John M. Brown,** from assistant superintendent to assistant manager-operations; **F. M. Jenkins,** from assistant superintendent of construction and maintenance to superintendent of construction and maintenance; **Joe D. Walk,** from assistant technical director to technical director; and **T. J. Byrne,** from chemical engineer to assistant technical director.

DEATHS

Paul H. Clark, 41, geologist for Humble Oil & Refining Co., Houston, died April 18.

Franklin F. Schauer, retired president of Equitable Gas Co. and Pittsburgh & West Virginia Gas Co., died recently in St. Petersburg, Fla. Widely known in the gas industry, Schauer joined Equitable in 1920 and rose through the positions of increasing responsibility to become head of the two companies in 1942.



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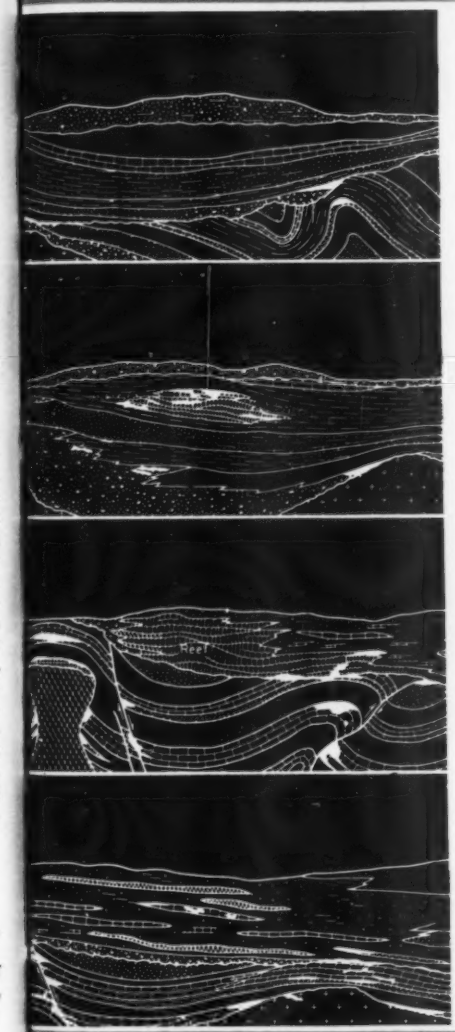
Exploration

SECTION



In this section you'll find:

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Also - -

"GEOPHYSICAL ACTIVITY" by E. A. Eckhardt, Gulf Research & Development Co., Pittsburgh.

"EXPLORATORY DRILLING" by Frederick H Lahee, Sun Oil Co., Dallas.

"GEOPHYSICAL FRONTIERS" by George A. Wagoner, Carter Oil Co., Shreveport.

These three papers give a broad, over-all picture of the past year's activity in the exploration world and thought-provoking ideas on the future. They were presented at the annual meeting of the American Association of Petroleum Geologists (thirty-sixth), the Society of Exploration Geophysicists (twenty-first), and the Society of Economic Paleontologists and Mineralogists (twenty-fifth), in St. Louis.

And - -

Abstracts of many of the papers presented at this joint annual meeting and a page of pictures of the officers-elect of the oil-finder groups are included.

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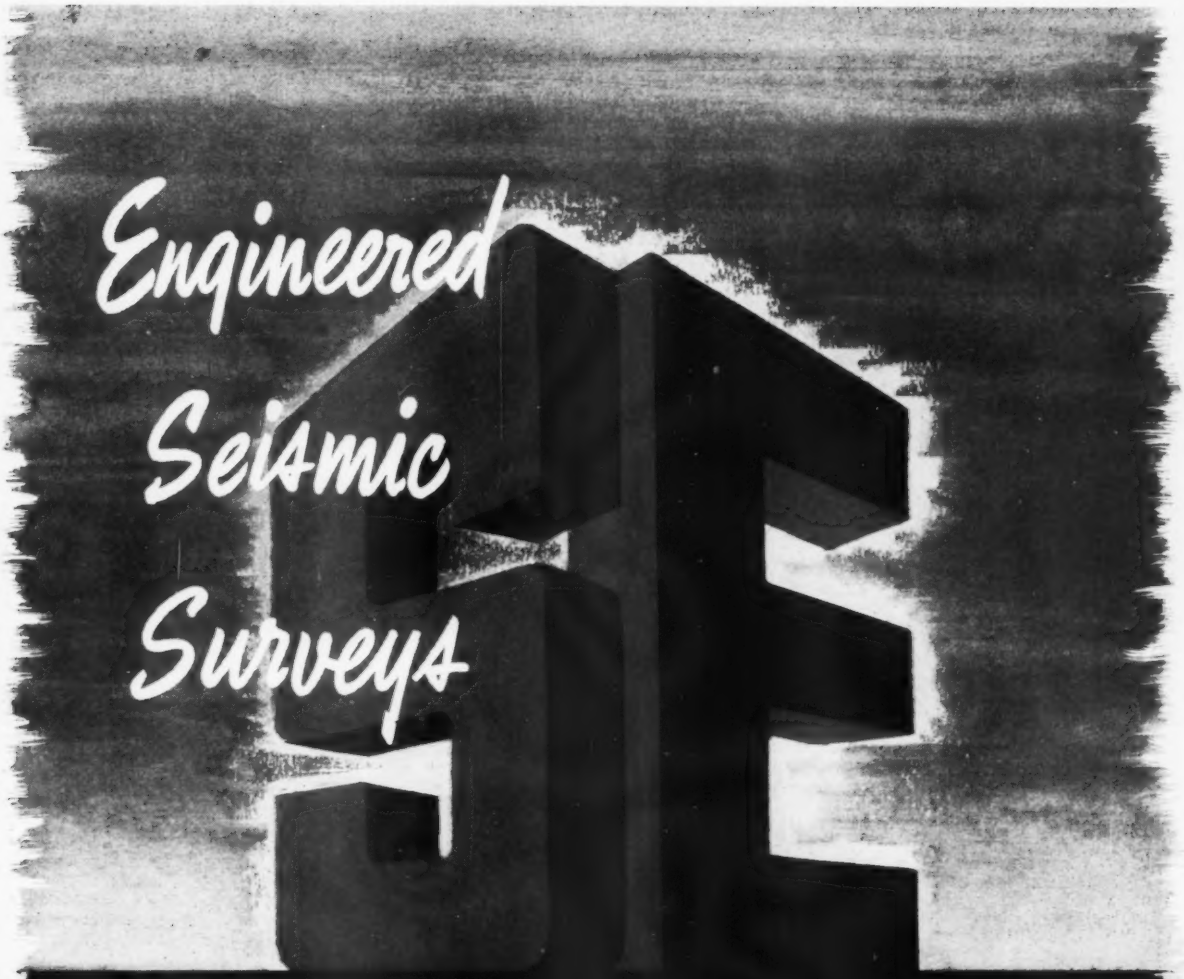

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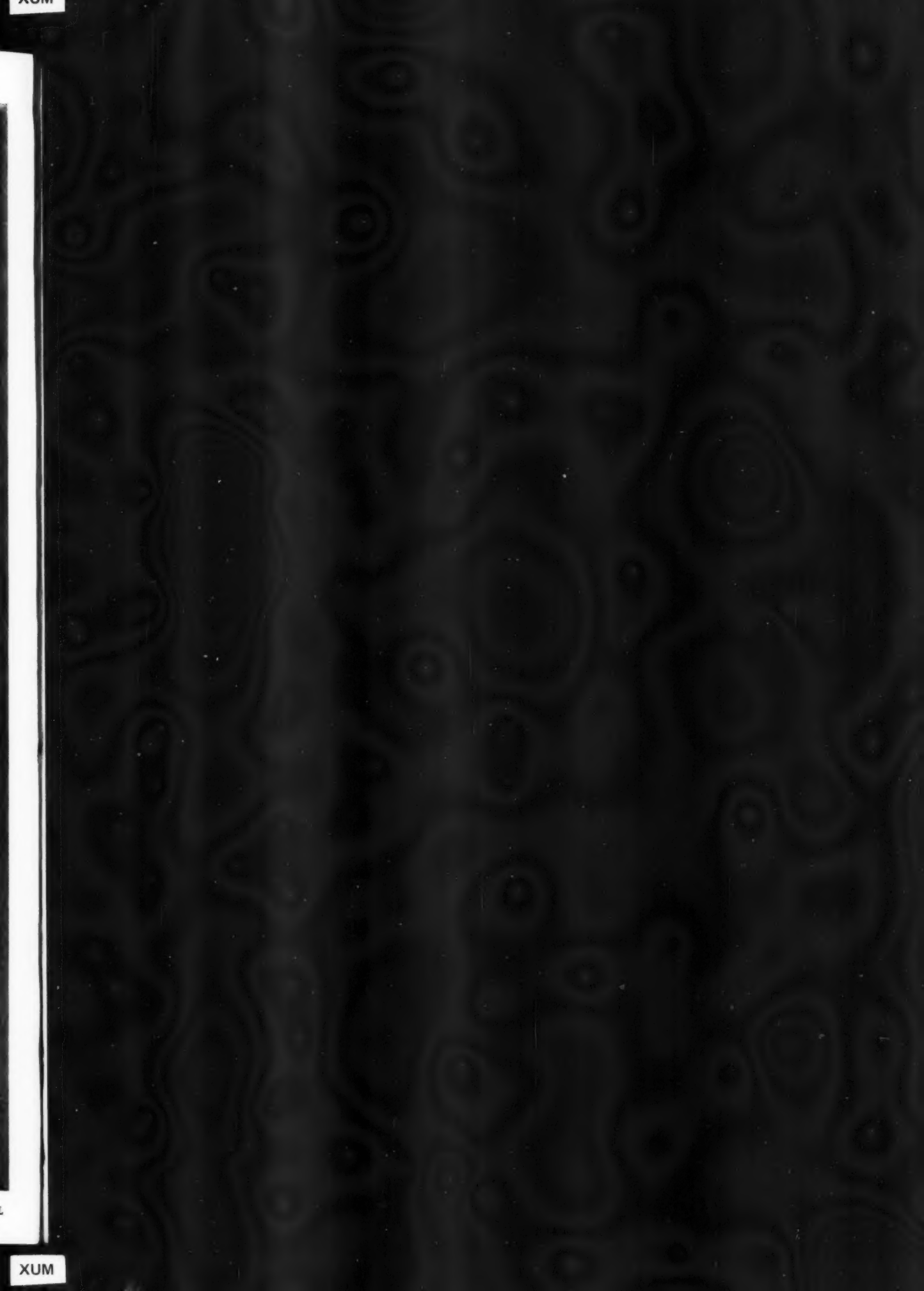

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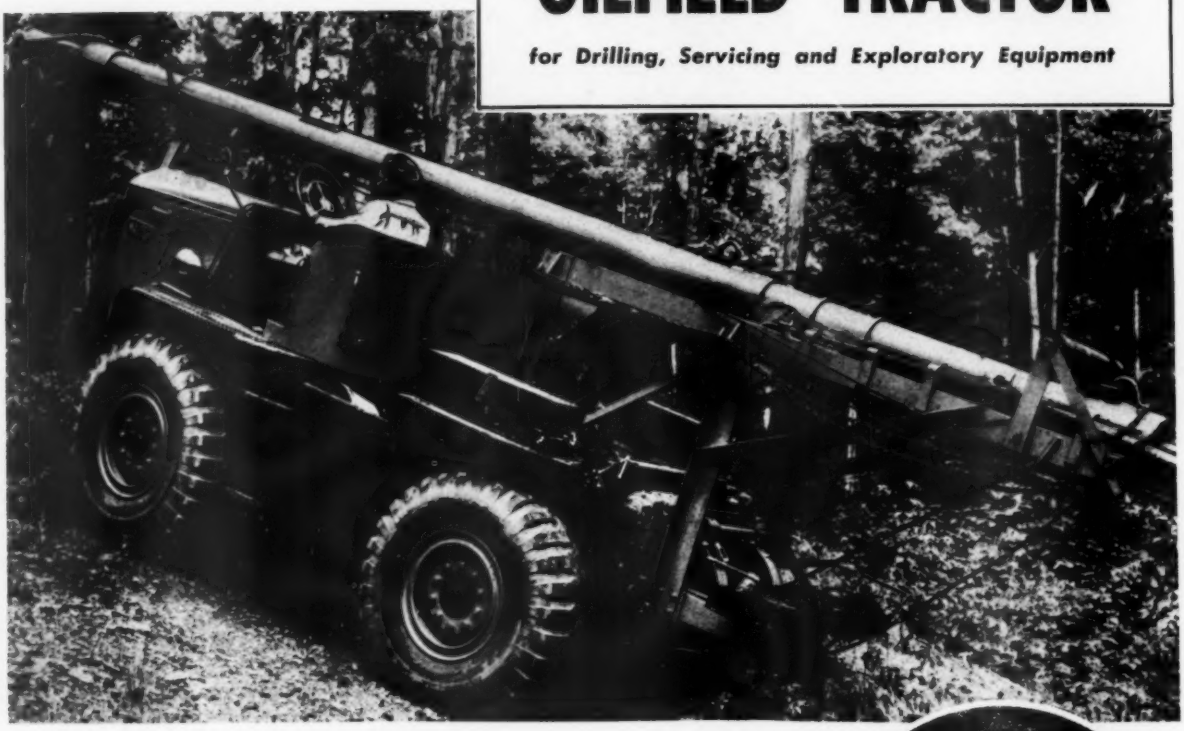

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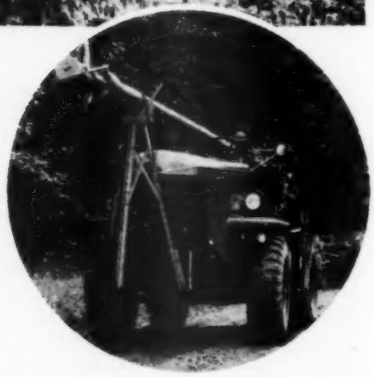

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THIS IS THE FIRST in the 1951 series of Standard Oil interpretive advertisements. This ad explains the company and its relation to the industry in which we operate, as well as the relationship of the company and the industry to the entire nation.

TOO BIG?

SHOULD IT BE SPLIT UP?

Of course these are silly questions.

One of the best things about the United States is that it *is* big—big enough to supply the needs of 151,000,000 Americans, and of many other millions the world over who are semi-dependent on American production.

And yet some men in this big country are critical of bigness.

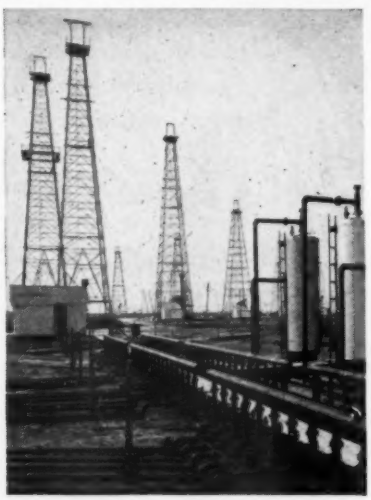
"Big Business" is their special target. They have urged that some of America's leading business organizations be split up, on the grounds that these companies are "too big" to serve the public interest.

They forget that it was the public's freedom of choice that made these businesses big. They forget that the ability of business to handle big jobs is what helps America in war and serves America in peace.

Companies stay big because millions of customers keep them big. The same people who helped make any business big can make it small again, if they find more satisfaction in buying the products and services of its competitors.

In this country, a company's bigness is one of the best proofs of its usefulness.

The United States is not the biggest country in the world, but it is one of the biggest. It has the highest standard of living for the greatest number, because Americans have always been free to produce for themselves and for each other. God gave us a rich land; competitive effort has made it richer. The United States has grown because its people have always believed in bigness, not as an end in itself but as a natural result and reward of worthy effort.



The petroleum industry is not the biggest industry in America, but it is one of the biggest. It contains many thousands of separate companies, large and small, competing with each other to serve you by steadily making petroleum more useful. The petroleum industry has grown big because it helps satisfy Americans' desire to live better. Military leaders say that the American petroleum industry's size and vigor have twice proved indispensable in war.

Our company is not the biggest company in the petroleum industry, but it is one of the biggest. From small beginnings, we and our subsidiary companies have grown into an integrated organization of more than 46,000 employees, working together to serve you. We have over 96,000 owners. We have millions of customers, all of them free to buy from our competitors. It is they who make us big—and we can stay big only as long as we serve them well.

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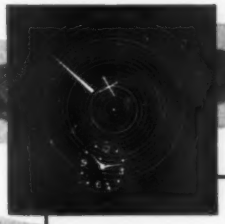

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If preferred SURWEL can be run on drill pipe. Here again it is a timesaver because the survey can be made at normal operating speed.

The design of the SURWEL makes it possible to use it where heat is so great that other instruments fail. The length of the instrument insures accurate alignment in the hole.

SURWEL surveys are fully computed including vertical depth correction. The Service Report includes a horizontal projection of the course of the well, the film records and original computations.

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Geophysical Activity IN 1950

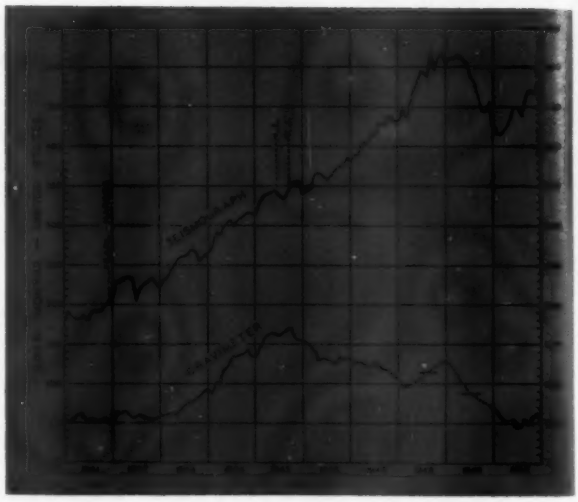


Fig. 1—Monthly variation in seismograph and gravimeter crew months in the United States.

by E. A. Eckhardt*

WHEN we reviewed the geophysical activity of 1949 at our meeting last year, we looked back on a considerable decline in the United States from a high of 520 seismograph crew-months in November 1948 to a low of 416 in February 1950, the last month for which information was then available. We did not know at the time whether the decline would continue and, if so, how far. The atmosphere was one of concern. We noted, however, that economic and other factors strongly indicated an early reversal and the future surpassing of earlier peaks.

We did not know at the time that the February 1950 level represented the bottom of the trough. The record for 1950 now makes clear that it was. Although the trend of 1950 was up, the total of seismograph crew-months in 1950 was less than it was in 1949, the decrease being approximately 6.9 per cent. This compares with a 1.4 per cent decrease from 1948 to 1949.

Gravity operations in the United States continued their 1949 decline somewhat longer, and the decrease was considerably more severe. The crew months in 1950 were over 45 per cent below those of the preceding

E. A. ECKHARDT

*Gulf Research & Development Co., Pittsburgh. Report of the Committee on Geophysical Activity of the Society of Exploration Geophysicists. The members of this committee are A. A. Brant, Herbert Hoover, Jr., D. C. Skeels and E. A. Eckhardt, chairman.

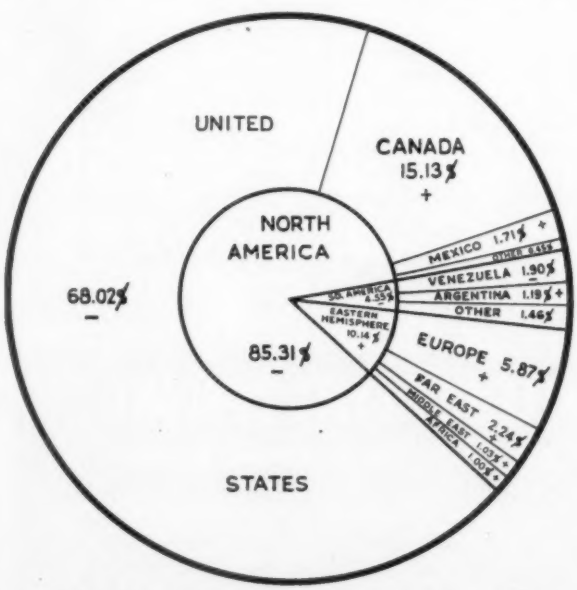


Fig. 2—World distribution of seismograph activity in 1950.

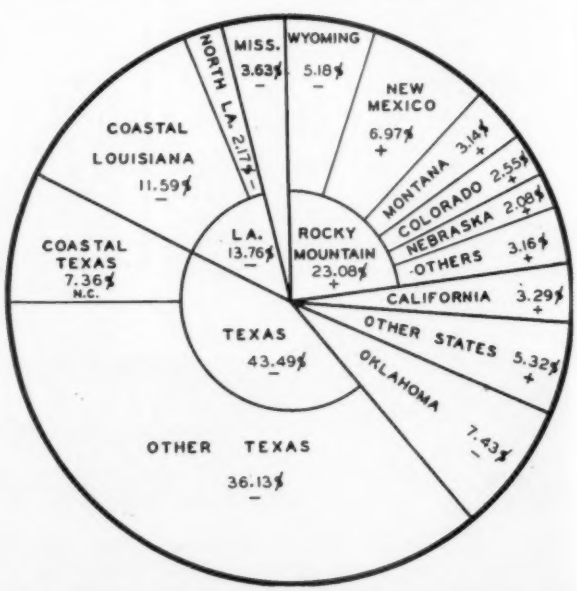


Fig. 3—Distribution of 1950 seismograph operations in United States.

year. During the latter part of last year a slight rising trend was in evidence.

The fluctuations of both seismograph and gravity operations from month to month over the past decade are shown in Fig. 1. It is a pleasure to say that the reporting of gravity operations is again on an entirely satisfactory basis and that the estimating, reflected by the dotted portion of the gravity curve, was not necessary for last year.

The number of seismograph crews operating in the United States during November 1950 is shown in Fig. 1 to be 478. A recent publication based on statistics furnished by the Interstate Oil Compact Commission gives the corresponding number as of November 30, 1950, to be 415. A similar discrepancy was pointed out in the report to the Society of Exploration Geophysicists last year. As was the case then, the difference arises almost entirely from the fact that the Compact Commission data do not include crews which operated in North Texas.

Similarly the gravity graph of Fig. 1 shows 62 parties to have operated in the United States during November 1950. The corresponding number of the Compact Commission is 47. The difference arises primarily from the fact that gravity activity in the Rocky Mountain states was substantially greater than that shown by the Compact Commission records.

The lower level of activity in the United States during last year represents one aspect of a trend away from this country. This is evidenced by the fact that, more than offsetting the United States decrease, there was an over-all increase in seismograph activity on a world-wide basis. This increase was a modest one, amounting to 2.5 per cent, which is roughly half the rate of increase for the year before. There was the equivalent of 657 full-time seismograph crews in operation during 1950.

The global gravity effort was less in 1950 than it was in the preceding year, but the decrease was only 25.8 per cent and therefore substantially less marked than that which occurred in the United States. The equivalent of 110 full-time gravity crews was reported as operating in 1950.

. From the statistical evidence which has been presented, it is possible to make a reasonable estimate as to what the geophysical operations of 1950 have cost the oil industry. Including a guestimate of the amounts spent on geophysical research and development, one comes up with approximately $205,000,000. This figure is more likely to be too small than too large. It covers only the geophysical component of exploratory costs. It does not include land and lease costs, geological work, core drilling, or the cost of exploratory wells.

Seismograph Activity

The world distribution of the seismograph work done in 1950 is shown in Fig. 2. In this figure, as well as others shown in this report, the plus and minus signs associated with the percentages indicate increases or decreases with respect to the preceding year. The most striking feature of this world picture is the substantial increase of activity in Canada, which jumped from 9.54 per cent of the world total in 1949 to 15.13 per cent in 1950. Almost, but not quite, equal to the gain in Canada was the loss in the United States, the percentage of which dropped from 74.87 to 68.01 per cent. Since the supply of trained geophysicists is quite limited, and cannot readily be expanded, the increase in Canada was probably largely at the expense of activity in the United States.

In South America the year 1950 witnessed a relatively severe shrinkage, and this continent's share of the total dropped from 6.29 per cent in 1949 to 4.55 per cent in 1950.

The reverse is true of the Eastern Hemisphere for which the percentage of the total increased from 7.53 per cent in 1949 to 10.14 per cent in 1950. The increase in Europe was most marked, especially that of Germany, but all divisions of the Eastern Hemisphere participated in the increase.

The distribution of 1950 seismograph operations in the United States is shown in Fig. 3. The share of Texas dropped slightly, that of Louisiana, Mississippi, and Oklahoma more markedly. The participation of the Rocky Mountain states increased substantially from 17.7 per cent of the total in 1949 to 23.1 per cent in 1950. Among the Rocky Mountain states, the share of Wyoming actually decreased from 7.7 to 5.2 per cent, but New Mexico's share increased from 3.7 to 7.0 per cent, almost doubling. All the other Rocky Mountain states showed relatively substantial increases. It is to be remembered that relative increases merely show better than average experience, since the sum total of all the work in the United States has decreased.

The magnitude and rate of growth of seismograph activity in Canada have been conspicuous in recent years. To gain perspective, however, it is useful to note that the 1950 activity in Canada was slightly less than that in the Rocky Mountain states and slightly over half of the activity in Texas.

Gravity Effort

The geographic distribution of

(Continued on page 185)

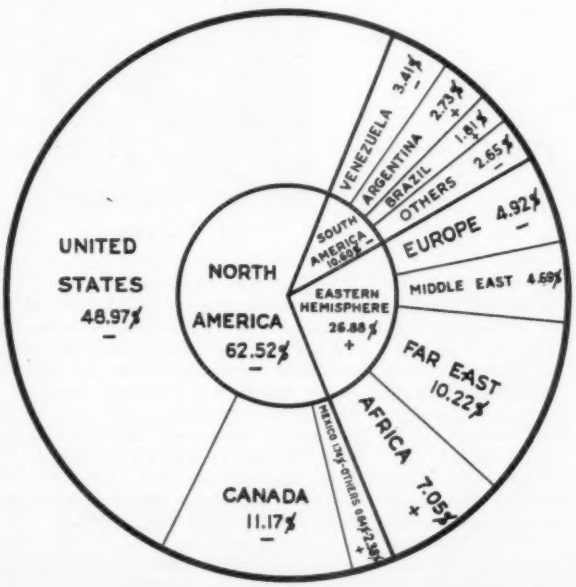


Fig. 4—World distribution of gravimeter activity in 1950.

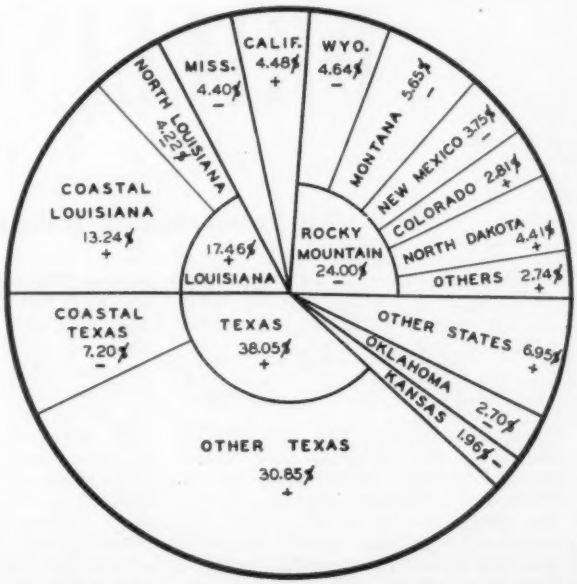


Fig. 5—Distribution of 1950 gravimeter operations in United States.

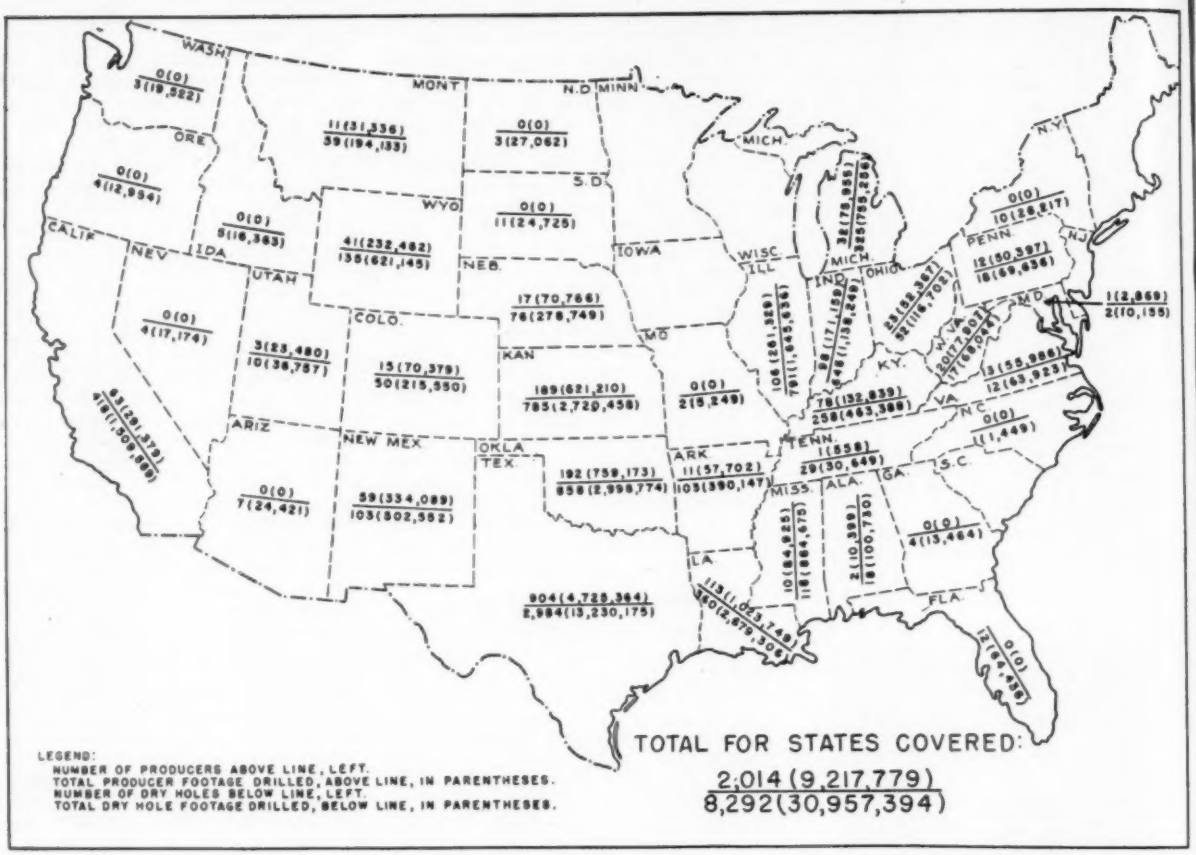
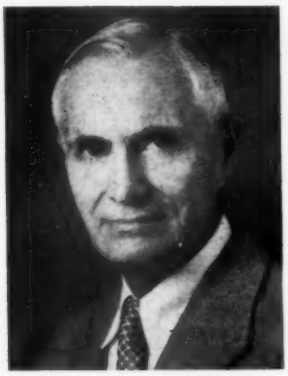


Fig. 1—Breakdown by states of number of dry holes and producers resulting from exploratory drilling in 1950, and footage drilled for each.

EXPLORATORY DRILLING IN 1950



F. H. LAHEE

by Frederick H. Lahee

This extensive digest of the report of the chairman of the American Association of Petroleum Geologists' Committee on Exploratory Statistics, prepared for presentation on April 26 at the association's annual meeting in St. Louis, is published by special permission of the author and the A.A.P.G. The full report will be printed in the June bulletin of the A.A.P.G. The author is geological and research counselor for Sun Oil Co., Dallas.

IN the states covered in this review, during 1950, a total of 40,175,173 ft. was drilled in 10,306 exploratory holes, divided as follows:

2,014 producers	9,217,779 ft.
8,292 dry holes	30,957,394 ft.

This means that 19.5 per cent of the holes, and 22.9 per cent of the footage drilled, were successful in 1950. One producer foot was drilled for every 4.35 ft. of dry hole. One successful well was drilled for every 4.11 dry holes. The average depth of hole was 3,898 ft.

In Table 3 are listed the reasons for drilling the new-field wildcats in 1950, by using the best information available from men familiar with such statistics, each in his own state or district. According to these figures 528 new-field wildcats drilled on technical advice (geology and/or geophysics) were successful, and 3,665 were dry; 7 holes, located for nontechnical reasons, were producers, and 227 were dry; 29 producers and 282 dry holes were located for reasons unknown. These figures show that 12.5 per cent of the holes drilled on technical advice were producers as contrasted to 3.0 per cent successful in the case of holes located without technical advice. Therefore, in 1950, locations for new-field wildcats based on technical

TABLE 1—CLASSIFICATION OF EXPLORATORY WELLS

			I. *Classification When Drilling Is Started*	II. *Classification After Completion or Abandonment*	
				Successful	*Unsuccessful*
			A	*B*	*C*
Drilling for long extension of partly developed pool			1 Outpost (Extension test)	1 Extension well (Sometimes a new-pool discovery well)	1 Dry outpost (Dry extension test)
Drilling for a *new pool* on a structure or in a geological environment already productive	New-pool tests	Drilling within limits of proved area of pool — For new pool above deepest pool	2a Shallower-pool test	New-pool discovery wells (Or sometimes extension wells): 2a Shallower-pool discovery well (Sometimes shallower-pool extension well)	Dry new-pool tests: 2a Dry shallower-pool test
		Drilling within limits of proved area of pool — For new pool *below* deepest pool	2b Deeper-pool test	2b Deeper-pool discovery well (Sometimes deeper-pool extension)	2b Dry deeper-pool test
		Drilling outside limits of proved area of pool	2c New-pool wildcat	2c New pool discovery wildcat (Sometimes an extension well)	2c Dry new-pool wildcat
Drilling for a *new field* (on a structure or in an environment never before productive)			3 New-field wildcat	3 New-field discovery wildcat	3 Dry new-field wildcat

recommendations were 4.16 times as successful as those drilled without such advice. Seismographic methods were largely responsible for 252 producers and 1,062 dry holes, among the new-field wildcats.

Table 4 summarizes the statistics on the basis for locating new-field wildcats in the United States for each of the years 1944 to 1950, inclusive.

Table 5 presents data on the footage drilled in new-field wildcats in the years 1944 to 1950, inclusive.

Table 6 gives a breakdown, by classes, of the exploratory holes drilled in 1950 in the United States. Each class is shown separately, both producers and dry holes, and the three types of new-pool tests are grouped together in Column 5.

In Table 7 is shown a percentage analysis of the exploratory drilling in 1950 and also in 1948 and 1949. In 1950, the percentage of new-field wildcatting in the entire exploratory drilling program, was just over 51 per cent. That for new-pool testing, and also that for outpost drilling, in each case, was just over 24 per cent.

In Table 8 are listed comparative data from 1938 to 1950, inclusive.

Table 9 will be of interest for it shows the relative success, as measured by the number of producers in comparison with the number of dry holes, in each year from 1944 to 1950, inclusive. The same data for all exploratory holes are graphically shown from 1938 to 1950 in Fig. 2.

As indicated in Table 1, a hole may be located as an outpost with the intention of trying to extend a pool partly developed, but instead it may discover a new pool; and, similarly, a new-pool wildcat may be located in search of a new pool because it is believed to be well outside the limits

TABLE 2—NUMBER OF OIL WELLS, GAS WELLS, CONDENSATE WELLS, AND DRY HOLES DRILLED IN UNITED STATES AS EXPORATORY TESTS IN 1950

State—	Oil producers		Gas producers		Condensate producers		Total producers		Dry holes		Grand total		Average depth of hole*
	No. of holes	Footage	No. of holes	Footage	No. of holes	Footage	No. of holes	Footage	No. of holes	Footage	No. of holes	Footage	
Alabama	1	8,093	1	2,306	0	0	2	10,399	18	100,730	20	111,129	....
Arizona	0	0	0	0	0	0	0	0	7	24,421	7	24,421	....
Arkansas	11	57,702	0	0	0	0	11	57,702	103	390,147	114	447,849	3,929
California	43	201,759	20	89,620	0	0	63	291,379	418	1,509,569	481	1,800,948	3,744
Colorado	7	40,057	8	30,322	0	0	15	70,379	50	215,550	65	285,929	4,398
Florida	0	0	0	0	0	0	0	0	12	64,436	12	64,436	....
Georgia	0	0	0	0	0	0	0	0	4	13,464	4	13,464	....
Idaho	0	0	0	0	0	0	0	0	5	16,363	5	16,363	....
Illinois	102	254,357	4	6,972	0	0	106	261,329	791	1,645,636	897	1,906,965	2,126
Indiana	90	160,197	8	10,962	0	0	98	171,159	645	1,138,249	743	1,309,408	1,762
Kansas	174	565,435	14	52,306	1	3,469	189	621,210	785	2,720,458	974	3,341,668	3,431
Kentucky	71	123,411	7	9,428	0	0	78	132,839	258	463,388	336	596,227	1,774
Louisiana	59	516,229	11	48,632	43	458,888	113	1,023,749	360	2,679,306	473	3,703,055	7,829
Maryland	0	0	1	2,869	0	0	1	2,869	2	10,155	3	13,024	....
Michigan	26	61,744	6	14,211	0	0	32	75,955	325	755,256	357	831,211	2,328
Mississippi	9	74,749	0	0	1	10,176	10	84,925	118	864,675	128	949,600	7,418
Missouri	0	0	0	0	0	0	0	0	2	5,249	2	5,249	....
Montana	7	22,902	4	8,434	0	0	11	31,336	59	194,133	70	225,469	3,221
Nebraska	10	35,141	7	35,625	0	0	17	70,766	76	278,749	93	349,515	3,758
Nevada	0	0	0	0	0	0	0	0	4	17,174	4	17,174	....
New Mexico	43	252,119	15	73,285	1	8,685	59	334,089	103	502,552	162	836,641	5,164
New York	0	0	0	0	0	0	0	0	10	26,217	10	26,217	....
North Carolina	0	0	0	0	0	0	0	0	1	1,449	1	1,449	....
North Dakota	0	0	0	0	0	0	0	0	3	27,062	3	27,062	....
Ohio	3	6,407	20	45,960	0	0	23	52,367	52	116,702	75	169,069	2,254
Oklahoma	169	657,258	17	59,003	6	42,912	192	759,173	858	2,998,774	1,050	3,757,947	3,579
Oregon	0	0	0	0	0	0	0	0	4	12,954	4	12,954	....
Pennsylvania	0	0	12	50,397	0	0	12	50,397	18	69,636	30	120,033	4,001
South Dakota	0	0	0	0	0	0	0	0	11	24,725	11	24,725	....
Tennessee	1	558	0	0	0	0	1	558	29	30,649	30	31,207	1,040
Texas	712	3,571,160	112	559,327	80	594,877	904	4,725,364	2,984	13,230,175	3,888	17,955,539	4,618
Utah	3	23,480	0	0	0	0	3	23,480	10	36,757	13	60,237	....
Virginia	2	2,760	11	53,226	0	0	13	55,586	12	63,923	25	119,909	4,796
Washington	0	0	0	0	0	0	0	0	3	19,522	3	19,522	....
West Virginia	1	2,056	19	75,851	0	0	20	77,907	17	68,044	37	145,951	3,944
Wyoming	39	224,184	2	8,278	0	0	41	232,462	135	621,145	176	853,607	4,850
Total	1,583	6,861,758	299	1,237,014	132	1,119,007	2,014	9,217,779	8,292	30,957,394	10,306	40,175,173	3,898
Average depth per hole		4,335		4,137		8,477		4,577		3,733		3,898	
Average depth based on total of exploratory holes drilled in 1945 to 1949, inclusive		4,384		4,109		8,383		4,627		3,783		3,951	

*Average per well footage given only where 25 or more wells drilled in a state.

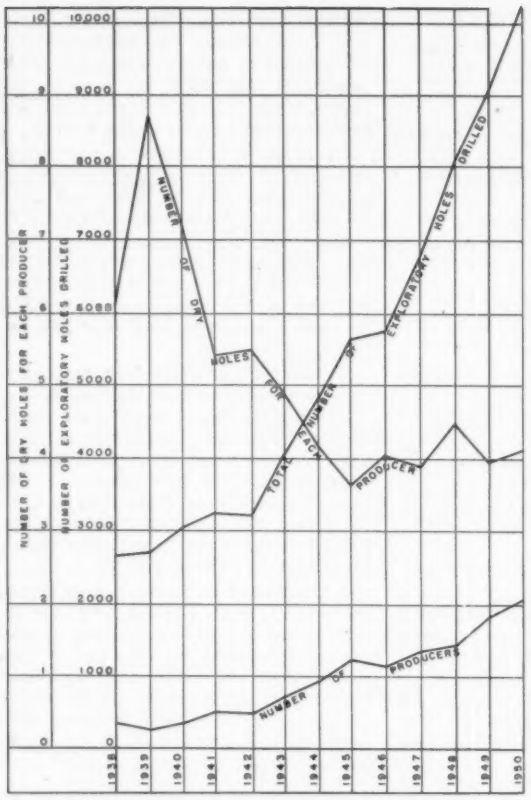


Fig. 2—Relative success of exploratory drilling in the United States from 1938 to 1950, inclusive.

of the known pool, but instead it may result in extending this known pool farther than had been expected. A majority of outposts, if successful, are completed as extension wells and a majority of new-pool wildcats, if successful, discover new pools. Table 10 shows the class distribution of these completions in 1950. Here it is seen that 613 outposts were completed as extension wells and 133 were completed as new-pool discoveries; and 258 new-pool wildcats discovered new pools whereas 141 new-pool wildcats were completed as extension wells.*

A question sometimes asked concerns the approximate percentage of true wildcatting (new-field wildcatting) by major companies, on the one hand, and by minor companies and independents, on the other hand. Distinction between these three classes of operator is not always easy, and in some instances the same company may be regarded as a "major" in one district, but as a "minor" in another district. Consequently we left the classification to the judgment of the various committeemen, each for his own district. Usually a major company is defined as one which is integrated with respect to at least three of the four main branches of production, transportation, refining, and marketing.

Our statistics showed that in the country as a whole in 1950, 848 new-field wildcats (183 producers and 665 dry holes) were drilled by majors; 4,019 new-field wildcats (368 producers and 3,651 dry holes) were drilled by minors and independents; and 423 new-field wildcats (41 producers and 382 dry holes) were drilled by minors or independents with the drilling financed by major companies.

In recent years we have included in our annual report a table showing the number of fields discovered each year, from 1938 to the year preceding the year reported, these fields being grouped according to a rough estimate of their total ultimate reserves from the date of discovery. The fields were grouped according to these estimates: "A" meaning a total ultimate of 50 million barrels or more; "B,"

*The new-pool discoveries referred to in this paper are all the result of exploratory drilling. In addition to these, at least 120 new pools were discovered in the drilling of field-development wells. These included 94 discoveries of oil, 6 of gas, and 20 of condensate.

TABLE 3—BASIS FOR LOCATING NEW-FIELD WILDCATS DRILLED IN 1950

State—	Geology		Geophysics*		Geology and geophysics		Sundry non-technical		Unknown		Total		Grand total
	Producers	Dry holes	Producers	Dry holes	Producers	Dry holes	Producers	Dry holes	Producers	Dry holes	Producers	Dry holes	
Alabama	1	4	1	9	0	3	0	1	0	0	2	17	19
Arizona	0	0	0	4	0	0	0	3	0	0	0	7	7
Arkansas	0	56	3	7	1	8	0	0	0	5	4	76	80
California	8	130	0	4	4	41	0	84	0	6	12	265	277
Colorado	0	14	6	8	3	3	0	14	0	1	9	40	49
Florida	0	3	0	6	0	0	0	1	0	0	0	10	10
Georgia	0	0	0	2	0	0	0	2	0	0	0	4	4
Idaho	0	5	0	0	0	0	0	0	0	0	0	5	5
Illinois	24	270	1	14	0	1	0	26	0	0	25	311	336
Indiana	25	316	1	43	1	1	3	18	0	45	30	423	453
Kansas	18	131	2	46	0	11	0	1	2	65	22	254	276
Kentucky	16	123	0	8	0	0	0	0	1	9	17	142	159
Louisiana	3	64	27	104	4	29	0	0	0	13	34	210	244
Maryland	1	1	0	0	0	0	0	0	0	0	1	1	2
Michigan	16	213	0	0	0	0	0	1	0	0	16	214	230
Mississippi	0	35	5	59	3	9	0	0	0	3	8	106	114
Missouri	0	0	0	0	0	0	0	0	0	2	0	2	2
Montana	1	20	1	11	0	8	0	4	0	0	2	43	45
Nebraska	1	12	6	29	0	0	0	18	0	11	7	68	75
Nevada	0	4	0	0	0	0	0	0	0	0	0	4	4
New Mexico	10	16	6	14	0	0	0	3	1	24	17	57	74
New York	0	2	0	0	0	0	0	3	0	0	0	5	5
North Carolina	0	0	0	0	0	0	0	0	0	1	0	1	1
North Dakota	0	1	0	1	0	0	0	1	0	0	0	3	3
Ohio	0	1	0	0	0	0	2	12	0	0	2	13	15
Oklahoma	39	294	16	72	3	7	4	57	6	27	68	457	525
Oregon	0	0	0	0	0	0	0	4	0	0	0	4	4
Pennsylvania	1	1	0	1	0	0	1	0	1	3	3	5	8
South Dakota	0	8	0	0	0	0	0	3	0	0	0	11	11
Tennessee	1	16	0	0	0	0	0	0	0	8	1	24	25
Texas	105	738	94	287	57	262	7	227	29	282	292	1,796	2,088
Utah	0	7	1	0	0	0	0	1	0	0	1	8	9
Virginia	3	7	0	0	0	0	0	0	0	0	3	7	10
Washington	0	0	0	1	0	1	0	1	0	0	0	3	3
West Virginia	4	7	0	0	0	0	0	0	0	2	4	9	13
Wyoming	2	24	3	9	5	19	2	41	0	0	12	93	105
Total	278	2,523	172	739	78	403	19	526	40	507	592	4,698	5,290

*Includes two successful wells and three unsuccessful wells drilled on geochemistry.

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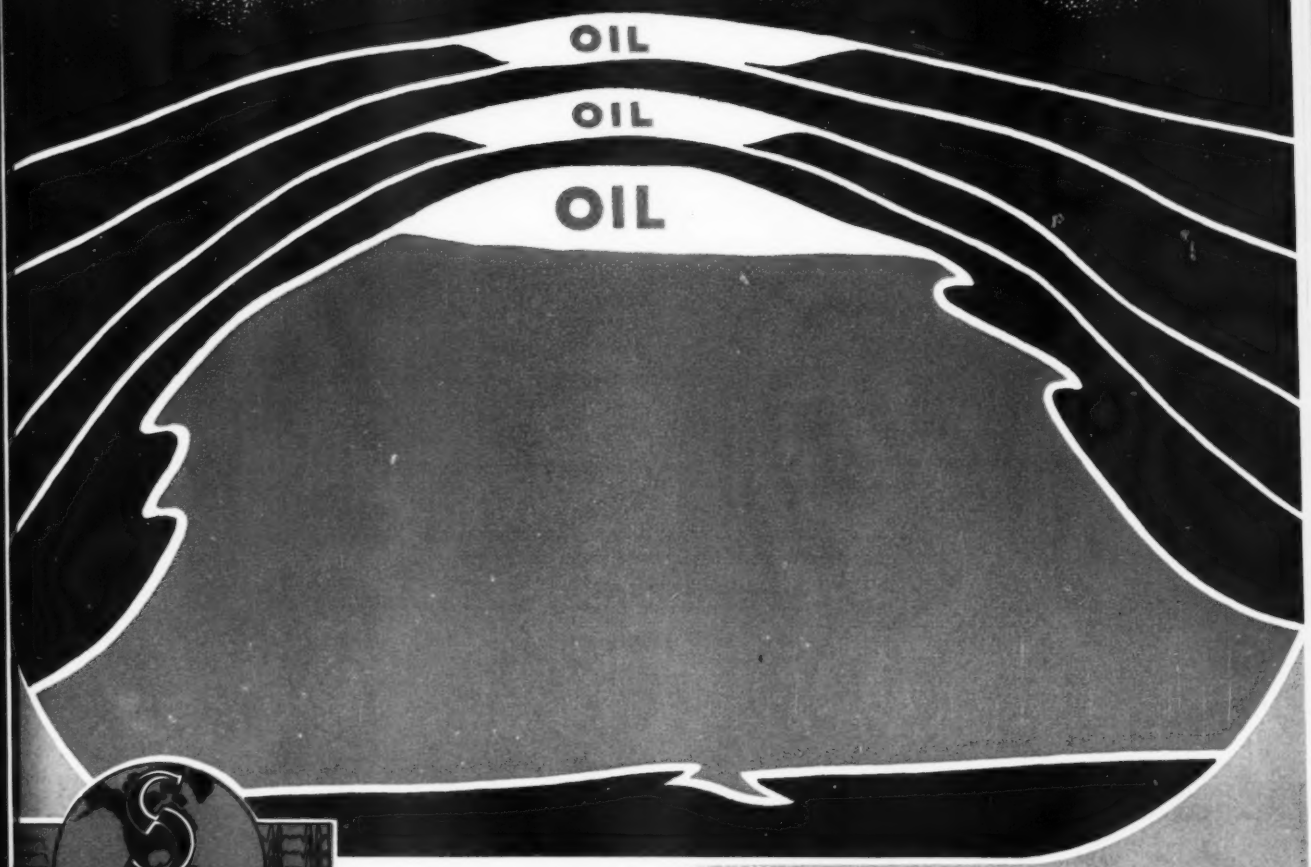
Are you looking for Reefs?



MARINE REEF (Illinois)

MADISON COUNTY

The above sketch is an idealized conception of the general geologic features.

The Marine reef is of the atoll type, probably an island in widespread Silurian seas. It was part of an archipelago which extended over at least five states and one Canadian province.

Oil occurs in the reef proper which thus far is normal for the area. Production is also obtained om formations draped over the reef. The thickness the Marine reef is about 400 feet.

One criterion used in the search for reefs of this pe is the facies change in both fossil content d lithologic character which occurs progresvely away from the reef.

SSC Recommends the Following Approach for Seismic Reef Exploration.

No. 5 ISOPACH ANALYSES

Thinning and thickening of sediments usually occur in the vicinity of organic reefs as a result of abnormal conditions of deposition and later compaction. Therefore, anomalous time isopachs can be indicative of reef trends or of the proximity of reef masses. SSC's METHODS OF RESOLUTION of this type of seismic data are INDISPENSABLE to a successful reef exploration program.

(This is one of a series)

Seismograph Service Corporation

TULSA, OKLAHOMA, U. S. A.

XUM

Fig. 3—Detailed data on exploratory drilling for Texas, Southeast New Mexico, Louisiana, and Arkansas.

Table 11 were all made in January 1950, those referring to discoveries in 1944 and 1947 being revisions, where revisions seemed necessary. In making these revisions, among the discoveries of 1947, 1 B was raised to A; 7 D's were raised to C; 1 D was raised to B; 3 C's were raised to B; 3 C's were raised to A; 20 E's were raised to D; 3 E's were raised to C; 4 D's were lowered to E; 22 E's were lowered to F; and 1 B was lowered to C. Among the discoveries of 1944, 2 C's were raised to B; 8 D's were raised to C; 17 E's were raised to D; 2 E's were raised to C; 3 D's were lowered to E; and 16 E's were lowered to F. These changes were made in the estimates prepared for these discoveries in 1947 and 1944 in January 1950. It is our plan to make these estimates of the fields discovered in any given year only 3 years and 6 years, respectively, after their dates of discovery, with a rough preliminary estimate given just after their discovery. It is very doubtful whether the first estimates for the discoveries of the year just elapsed can be of much significance, for not enough is yet known of the various factors which should enter into an estimate of this kind.

In conclusion with reference to exploratory drilling in the United States, comparing 1950 figures with those of 1949, we note the following:

1. In number of exploratory holes drilled there was an increase of 13.7 per cent, and in exploratory footage drilled there was an increase of 15.1 per cent.

TABLE 4—BASIS FOR LOCATING NEW-FIELD WILDCATS
(For all states reported in United States)

Year	Geology		Geophysics*		Geology and geophysics		Total technical		Nontechnical		Unknown		Total		Grand total
	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	
1944	148	1,328	108	589	40	177	296	2,094	38	570	8	88	342	2,752	3,094
1945	180	1,488	89	468	53	220	322	2,176	17	302	13	207	352	2,685	3,037
1946	154	1,584	91	413	57	211	302	2,208	10	363	21	†229	333	†2,800	†3,133
1947	200	1,691	100	514	63	295	364	2,500	15	389	15	197	394	3,086	3,480
1948	232	2,039	124	595	99	400	455	3,034	12	372	34	389	501	3,795	4,296
1949	222	2,133	180	650	62	360	464	3,143	11	367	30	433	506	3,943	4,449
1950	278	2,523	172	739	78	403	528	3,665	19	526	40	507	592	4,698	5,290

*Includes a few holes based on geochemistry. †See note referring to North Carolina exploratory drilling, Bull. A.A.P.G., Vol. 33, p. 1903. Correction has been made in the table above.

TABLE 5—FOOTAGE DRILLED IN NEW-FIELD WILDCATS
(For all states reported in United States)

Year	No. of producers	No. of dry holes	Total producers and dry holes	Total feet drilled in producers	Total feet drilled in dry holes	Total feet drilled in all new-field wildcats	Average depth of new-field wildcats
1944	342	2,752	3,094	1,640,473	11,356,749	12,997,222	4,200
1945	352	2,685	3,037	1,789,392	11,579,385	13,368,777	4,402
1946*	333	2,800	3,133	1,692,977	10,862,145	12,555,122	4,007
1947	394	3,086	3,480	2,096,864	12,520,723	14,617,587	4,200
1948	501	3,795	4,296	2,690,951	16,049,313	18,740,264	4,362
1949	506	3,943	4,449	2,786,774	15,372,983	18,159,757	4,082
1950	592	4,698	5,290	3,146,090	18,972,164	22,118,254	4,177

*See note referring to North Carolina exploratory drilling, Bull. A.A.P.G., Vol. 33, p. 1903. Correction has been made in the table above.

from 25 to 50 million barrels; "C," from 10 to 25 million barrels, "D," from 1 to 10 million barrels; "E," less than 1 million barrels; and "F," abandoned. Gas fields were not included unless they also produced condensate. A few fields were omitted where satisfactory estimates were not readily obtainable.

In the present report, we are repeating our approach of last year. We are recording, in Table 11, estimated total ultimate reserves only for the discoveries of 1944, 1947, and 1950. This is the second year in which we have attempted such an estimate of the fields discovered in the year just closed. Previously we have allowed a year to elapse. The estimates in

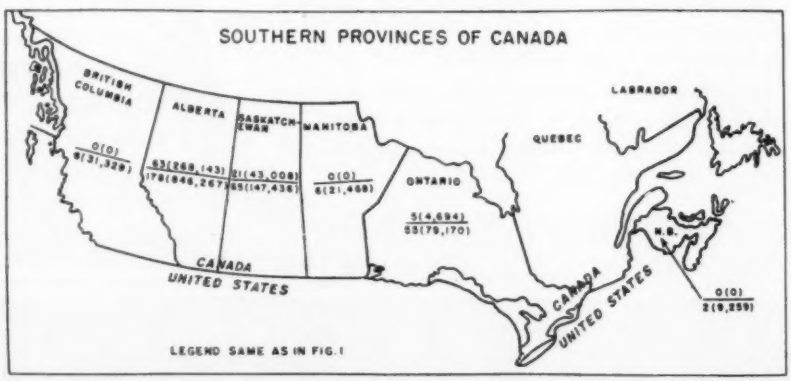
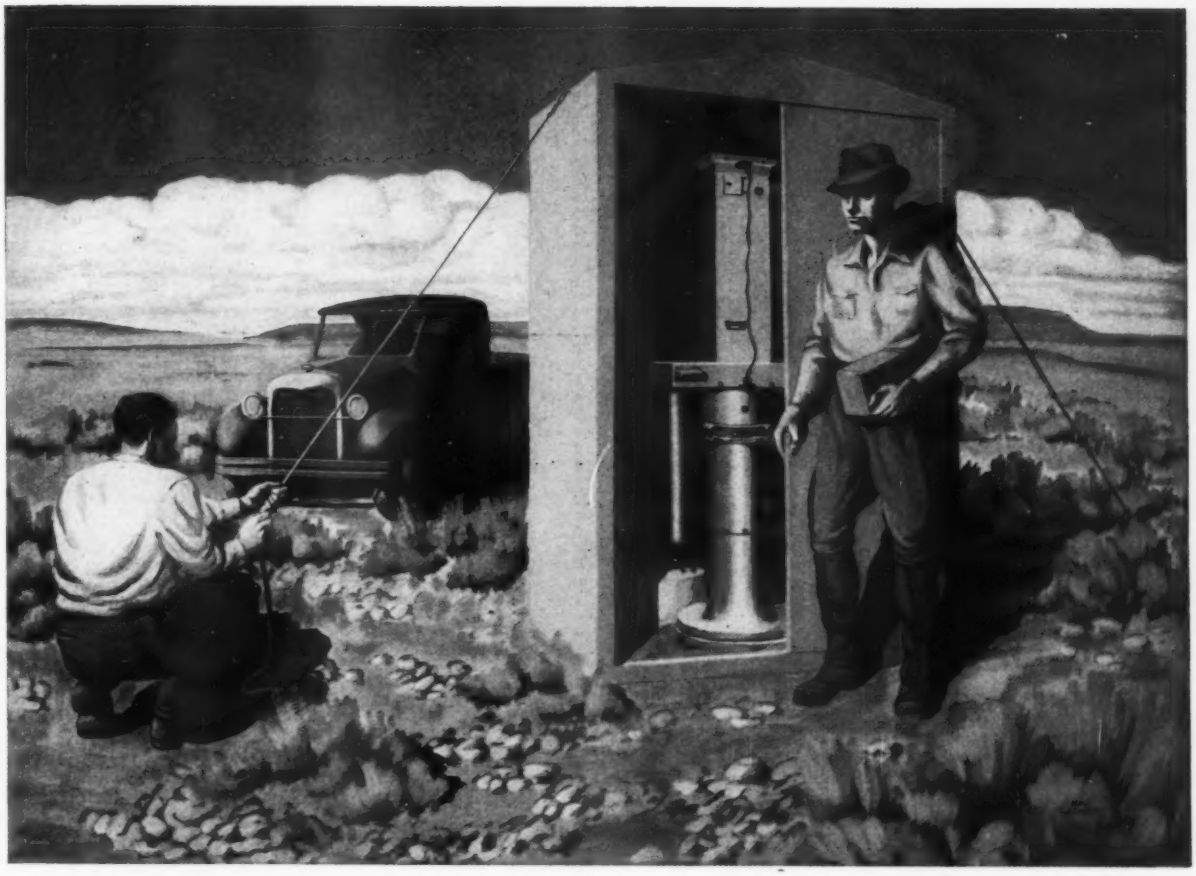


Fig. 4—Exploratory drilling details for Canada's southern provinces for 1950.



CHAPTER SIX in the fascinating Story of the Search for Oil

In 1928

The first of the geophysical methods to be used in oil prospecting was that of surveys of variations in the earth's gravitational field by the use of the Eotvos torsion balance. The torsion balance was essentially a modification into a comparatively robust field instrument of the older and more fragile Coulomb balance which had been used in physical laboratories since the 18th century for investigating and demonstrating the laws of gravitational attraction. About 1920, E. DeGolyer, then head of the Amerada-Rycade Oil Companies, became interested in the instrument. In 1922, Donald C. Barton proceeded to Budapest at DeGolyer's instance and acquired two of the balances. The first torsion balance surveys in the United States were made in the Spindletop, Texas salt dome field in early December, 1922, but the first geophysical prospect to be proved in the United States was on the Nash Ranch in Fort Bend County, Texas, where oil was discovered on the flank of a salt dome on January 3, 1926. The use of torsion balance for oil prospecting reached its peak in 1928-29. From E. DeGolyer's book, *"The Development of the Art of Prospecting,"* and from a report by Dr. J. Brian Eby.

In 1951

With the commemoration this year of the 50th Anniversary of the discovery of the Spindletop field, the oil industry has moved into a new era which will demand more petroleum products than any other period in the history of the world. In order to help locate these reserves for the future, General Geophysical now has more crews in the field than at any other period in the history of the company. Working with specialized seismograph equipment . . . developed in General laboratories to meet specific needs for various areas . . . these General Geophysical crews are scattered from Canada to the Gulf Coast. And from the data compiled by these capable crews, geologists and geological departments within the next few years will make the key decision to drill hundreds of wells. For more than 15 years, operators have relied on General's experienced crews to determine and locate conditions favorable to finding new oil reserves. So when you plan to explore new areas and deeper horizons for tomorrow's reserves, let General help you. The percentage for success is in your favor.

General GGC

GEOPHYSICAL COMPANY

GULF BLDG. HOUSTON

A PRINT OF THIS ILLUSTRATION SUITABLE FOR FRAMING WILL BE SENT ON REQUEST

TABLE 6—NUMBER OF EXPLORATORY HOLES DRILLED IN UNITED STATES IN 1950, BY CLASSES AND STATES

	1		2		3		4		5		6		7	8
	Outposts		New-pool wildcats		Deeper-pool tests		Shallower-pool tests		Total new-pool tests (2+3+4)		New-field wildcats		Total exploratory holes Total (1+5+6)	
State—	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	Grand total
Alabama	0	0	0	1	0	0	0	0	0	1	2	17	2	18	20
Arizona	0	0	0	0	0	0	0	0	0	0	0	7	0	7	7
Arkansas	1	12	4	13	2	2	0	0	6	15	4	76	11	103	114
California	47	64	1	76	1	13	2	0	4	89	12	265	63	418	481
Colorado	4	10	0	0	1	0	1	0	2	0	9	40	15	50	65
Florida	0	2	0	0	0	0	0	0	0	0	0	10	0	12	12
Georgia	0	0	0	0	0	0	0	0	0	0	0	4	0	4	4
Illinois	76	358	0	61	3	60	2	1	5	122	25	311	106	791	897
Indiana	29	65	37	157	2	0	0	0	39	157	30	423	98	645	743
Kansas	61	105	74	425	9	1	23	0	106	426	22	254	189	785	974
Kentucky	40	38	20	72	1	6	0	0	21	78	17	142	78	258	336
Idaho	0	0	0	0	0	0	0	0	0	0	0	5	0	5	5
Louisiana	57	90	11	45	4	14	7	1	22	60	34	210	113	360	473
Maryland	0	0	0	1	0	0	0	0	0	1	1	1	1	2	3
Michigan	9	72	5	36	1	2	1	1	7	39	16	214	32	325	357
Mississippi	0	9	0	2	1	1	1	0	2	3	8	106	10	118	128
Missouri	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2
Montana	6	7	3	7	0	2	0	0	3	9	2	43	11	59	70
Nebraska	7	5	1	3	1	0	1	0	3	3	7	68	17	76	93
Nevada	0	0	0	0	0	0	0	0	0	0	0	4	0	4	4
New Mexico	25	27	9	14	3	5	5	0	17	19	17	57	59	103	163
New York	0	0	0	5	0	0	0	0	0	0	0	5	0	10	10
North Carolina	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
North Dakota	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3
Ohio	11	14	9	20	0	3	1	2	10	25	2	13	23	52	75
Oklahoma	60	213	31	181	18	6	15	1	64	188	68	457	192	858	1,050
Oregon	0	0	0	0	0	0	0	0	0	0	0	4	0	4	4
Pennsylvania	7	5	0	6	2	2	0	0	2	8	3	5	12	18	30
South Dakota	0	0	0	0	0	0	0	0	0	0	0	11	0	11	11
Tennessee	0	4	0	1	0	0	0	0	0	1	1	24	1	29	30
Texas	314	604	194	472	56	98	48	14	298	584	292	1,796	904	2,984	3,888
Utah	1	1	0	0	0	0	1	1	1	1	1	8	3	10	13
Virginia	10	5	0	0	0	0	0	0	0	0	3	7	13	12	25
Washington	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3
West Virginia	5	4	10	4	0	0	1	0	11	4	4	9	20	17	37
Wyoming	10	27	9	7	2	8	8	0	19	15	12	93	41	135	176
Total U. S.	780	1,741	418	1,609	107	223	117	21	642	1,853	592	4,698	2,014	8,292	10,306

2. Considering only the new-field wildcats, 1950 witnessed an increase of 18.8 per cent in holes drilled and an increase of 21.7 per cent in footage drilled, compared with 1949.

3. In Illinois, Indiana, Kansas, Kentucky, Nebraska, New Mexico, and Oklahoma, there were large increases in exploratory drilling in 1950, contrasted with 1949, but there was a decrease in California.

4. The average depth of hole for all exploratory drilling increased from 3,842 ft. in 1949 to 3,898 ft. in 1950. Again, this year, Louisiana holds the record (7,829 ft.) for average depth of exploratory hole, and Mississippi is again second with 7,418 ft.

Exploratory Drilling in Canada

In western Canada, in 1950, 341 exploratory holes were completed, 84 of these being producers and 257 being dry holes. The producers included 65 oil wells, 18 gas wells, and 1 condensate well. A total of 1,357,651 ft. was drilled, 311,151 in producers and 1,046,500 ft. in dry holes. This means that 24.63 per cent of the exploratory holes and 22.91 per cent of the exploratory footage were successful. There were 3.4 ft. drilled in dry holes for every foot drilled in producers. For every producer completed, 2.43 dry holes were abandoned. The average depth of all the exploratory holes was 3,981 ft.

Among the 274 new-field wildcats completed in western Canada in 1950, 42 were successful and 232 were dry. In other words, new-field wildcatting was 15.3 per cent successful. One producer was drilled for every 6.5 dry holes. In Alberta 54 of the new-field wildcats were drilled by majors, and

TABLE 7—PERCENTAGE OF EXPLORATORY HOLES DRILLED IN EACH CLASS IN THE UNITED STATES IN 1948, 1949, AND 1950

	1948			1949			1950		
	Number	Well per cent	Class per cent	Number	Well per cent	Class per cent	Number	Well per cent	Class per cent
Outposts:									
Producers	490	27.74		668	31.04		780	30.94	
Dry holes	1,276	72.26		1,484	68.96		1,741	69.06	
Total	1,766	100.00	22.04	2,152	100.00	23.76	2,521	100.00	24.46
New-pool wildcats:									
Producers	325	22.12		469	25.11		418	20.13	
Dry holes	1,144	77.88		1,399	74.89		1,609	79.87	
Total	1,469	100.00	19.33	1,868	100.00	20.62	2,027	100.00	19.67
Deeper-pool tests:									
Producers	117	27.02		130	25.89		107	32.42	
Dry holes	316	72.98		372	74.11		223	67.58	
Total	433	100.00	5.40	502	100.00	5.54	330	100.00	3.20
Shallower-pool tests:									
Producers	30	58.82		57	65.52		117	84.76	
Dry holes	19	41.18		30	34.48		21	15.24	
Total	49	100.00	0.61	87	100.00	0.96	138	100.00	1.34
New-field wildcats:									
Producers	501	11.66		506	11.37		592	11.19	
Dry holes	3,795	88.34		3,943	88.63		4,698	88.81	
Total	4,296	100.00	53.62	4,449	100.00	49.12	5,290	100.00	51.33
Total producers	1,463	18.25		1,830	20.20		2,014	19.54	
Total dry holes	6,550	81.75		7,228	79.80		8,292	80.46	
Grand total	8,013	100.00	100.00	9,058	100.00	100.00	10,306	100.00	100.00

TABLE 8—STATISTICS ON EXPLORATORY HOLES AND FOOTAGE DRILLED, AND ON AVERAGE DEPTH OF EXPLORATORY HOLE IN UNITED STATES

	A	B	C	D	E	F	G	H	I	J	K
	Successful exploratory wells										
Year	Total producers*	New-field discovery wells	B is what per cent of A	No. of dry exploratory holes	Total exploratory holes (A+D)	No. of dry exploratory holes drilled for each producer (D/A)	Total footage in successful exploratory holes	Total footage in dry exploratory holes	No. of feet drilled in dry holes for each foot in producers (H/G)	Total exploratory footage (G+H)	Average depth of exploratory hole (J/E)
1938	294 oil, 75 gas	369	226	61.2	2,269	2,638	6.14	1,526,557	7,333,927	4.84	8,860,484	3,359
1939†	226 oil, 49 gas	275	175	63.6	2,427	2,702	8.81	1,118,420	7,674,677	6.86	8,793,097	3,331
1940	302 oil, 64 gas	366	241	65.8	2,672	3,038	7.30	1,411,550	8,842,418	6.26	10,253,948	3,375
1941	416 oil, 60 gas, 27 cond.	503	282	56.1	2,761	3,264	5.48	2,047,377	9,567,708	4.66	11,615,085	3,559
1942	410 oil, 53 gas, 29 cond.	492	268	54.5	2,720	3,212	5.52	2,158,707	9,965,287	4.62	12,123,994	3,775
1943‡	530 oil, 147 gas, 37 cond.	714	400	56.0	3,294	4,008	4.61	2,936,266	12,783,447	4.35	15,719,713	3,922
1944	709 oil, 149 gas, 86 cond.	944	342	36.2	3,852	4,796	4.08	4,382,220	15,843,667	3.61	20,225,887	4,217
1945	840 oil, 274 gas, 100 cond.	1,214	352	29.0	4,399	5,613	3.62	5,501,702	17,528,564	3.19	23,030,266	4,103
1946¶	762 oil, 272 gas, 103 cond.	1,137	333	29.3	4,622	5,759	4.06	5,286,711	16,911,032	3.18	22,197,743	3,854
1947	981 oil, 325 gas, 72 cond.	1,378	394	28.6	5,397	6,775	3.90	6,166,163	20,227,185	3.28	26,393,348	3,896
1948	1,098 oil, 255 gas, 110 cond.	1,463	501	34.2	6,550	8,013	4.48	7,179,450	25,561,647	3.56	32,741,097	4,086
1949	1,406 oil, 285 gas, 139 cond.	1,830	506	27.6	7,228	9,058	3.95	8,359,690	26,438,601	3.16	34,798,291	3,842
1950	1,583 oil, 299 gas, 132 cond.	2,014	592	29.4	8,292	10,306	4.11	9,217,779	30,957,394	4.35	40,175,173	3,898

*In the years 1938 to 1940, inclusive, condensate-plus-gas wells are included with gas wells. After 1940 gas wells and condensate-plus-gas wells are listed separately in this table. †Kentucky statistics were added for 1939 after publication of that year's report. ‡Statistics for New York, Pennsylvania, and eastern Ohio have been included here in 1943, although they came in too late for publication in the 1943 report. ¶Six dry new-field wildcats, with a total of 30,182 ft., drilled in North Carolina and omitted by mistake in the 1946 report, were added here in Table 8 in the 1949 report.

TABLE 9—RELATIVE SUCCESS OF EXPLORATORY DRILLING IN UNITED STATES FROM 1944 TO 1950, INCLUSIVE

	New-field wildcats		All exploratory holes	
Year	No. of dry holes for each producer	Percentage of wells successful	No. of dry holes for each producer	Percentage of wells successful
1944	8.05	11.05	4.08	19.67
1945	7.63	11.59	3.62	21.64
1946	8.39	10.65	4.06	19.76
1947	7.80	11.32	3.90	20.34
1948	7.57	11.66	4.50	18.25
1949	7.79	11.37	3.95	20.20
1950	8.93	11.19	4.11	19.54
Avg. for 7 years	8.02	11.26	4.03	19.91

133 by minors and independents. The bases for location of the new-field wildcats in Alberta are shown in Table 13.

In eastern Canada, 62 exploratory holes were drilled, with a total of 93,123 ft. Of the 62 holes, 5 were successful, 4 as gas wells and 1 as an oil well, and all in southwestern Ontario. In these producers, 4,694 ft. was drilled. Of the 62 holes, 8.1 per cent were successful. Five per cent of the exploratory footage was in successful holes. For every foot drilled in producers, 18.8 ft. were drilled in dry holes. The average depth of hole was 1,502 ft.

All but 10 of these exploratory holes in eastern Canada were new-field wildcats. There were two successful new-field wildcats.

The distribution of the 62 holes was as follows:

Ontario:
- 1 extension well
- 5 dry outposts
- 1 dry new-pool wildcat
- 2 successful deeper-pool tests
- 1 dry deeper-pool test
- 2 successful new-field wildcats
- 48 dry new-field wildcats

New Brunswick:
- 2 dry new-field wildcats

Concluding Remarks

In concluding this review, we want to call especial attention to the subject of our recent article, published in the 1950 A.A.P.G. bulletin, entitled "Degrees of Success in Wildcat Drilling."* In that article we have pointed out that, although wildcats that discover new fields ("new-field wildcats," or "rank wildcats") are listed as "successful" in contrast to those which are abandoned immediately or

*See The Oil and Gas Journal, January 4, 1951, page 22.

TABLE 10—NEW-POOL DISCOVERIES* AND EXTENSIONS OF OLDER POOLS IN UNITED STATES IN 1950

	New pools* discovered in 1950					Extensions of old pools in 1950				
	By outposts	By new-pool wildcats	By deeper-pool tests	By shallower-pool tests	Total new pools discovered in 1950	By outposts	By new-pool wildcats	By deeper-pool tests	By shallower-pool tests	Total extensions in 1950
Oil	90	216	83	91	480	497	127	4	6	634
Gas	28	29	12	10	79	77	6	0	0	83
Condensate	15	13	6	7	41	39	8	0	0	47
Total	133	258	101	108	600	613	141	4	6	764

*This table does not include discoveries of new fields.

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shortly after drilling as "dry," there is a great variation in the degrees of success. Measuring these degrees on the basis of estimated total ultimate recovery from each of the fields discovered in the years 1944, 1945, and 1946, we showed that:

"Only 1 well out of every 44 new-field (rank) wildcats discovered a field with more than 1 million barrels of total ultimate recoverable reserves.

"Only 1 well out of every 243 new-field (rank) wildcats discovered a field with more than 10 million barrels of total ultimate recoverable reserves.

"Only 1 well out of every 967 new-field (rank) wildcats discovered a field with more than 50 million barrels of total ultimate recoverable reserves, that is, what we usually regard as a major field."

These figures were based on a total of 8,696 new-field wildcats drilled in the 3-year period mentioned. Eight thousand and five (92.1 per cent) of these wildcats were failures; 487 (5.6 per cent) discovered fields with a total ultimate recoverable reserve of less than 1 million barrels; and only 204 (2.3 per cent) discovered fields with a total ultimate recoverable reserve of more than 1 million barrels. "Roughly speaking, and using averages for depth of drilling, number of field-development wells required to drill up a field, number of dry holes drilled to outline the edges of the field, etc., we may assume that a field having a total ultimate recovery of 1 million barrels is, on the average, near the economic limit. In some districts such a small field will pay moderate profits; in others, there will be a net financial loss; all depending on factors of depth to the 'pay' or reservoir, difficulties in drilling, permeability and thickness of reservoir rock, accessibility, etc."

These figures, which may be safely used as essentially representative of conditions today, spell a very significant story of the risk involved in actual wildcat drilling.

While on this subject it may be of interest to report a brief analysis on the results of deep wildcat drilling. From 1944 to 1949, inclusive, our data for the United States show that 1,040 new-field wildcats were drilled to depths exceeding 10,000 ft. Four hundred and fifty-eight of these were completed between 10,000 and 10,999 ft.; 295 of them, between 11,000 and 11,999 ft.; and 287 of them, at 12,000 or more feet.

In the first group there were 48 oil wells, 12 gas wells, 37 condensate-plus-gas wells, and 361 dry holes; in the second group there were 40 oil wells, 10 gas wells, 23 condensate-plus-gas wells, and 222 dry holes; and in the third group there were 34 oil wells, 4 gas wells, 31 condensate-plus-gas wells, and 218 dry holes.

Taking only the third group—those drilled to depths of 12,000 ft. or more—only eight of the oil-field discoveries are now rated as likely to produce an ultimate of over 1 million barrels. Seven of these oil-field discoveries have been abandoned. Only three of the gas fields and six of the condensate-plus-gas fields are now estimated to have a total ultimate recoverable yield of more than 10 billion cubic feet of gas. It is quite likely that some of these fields will prove to be larger than at present estimated, after several more years of development history, but the main point is, again, that the mere number of new-field wildcats listed as discovery wells is not a satisfactory measure of the successfulness of wildcat drilling. The actual degree of success, if measured in barrels or cubic feet ultimately recoverable from the discovered fields, is definitely of a lower order.

TABLE 13—BASIS FOR LOCATION OF NEW-FIELD WILDCATS IN ALBERTA

	Geology	Geo-physics	Geology and geophysics	Total technical	Non-technical	Unknown	Total
Producers	5	24	8	37	0	1	38
Dry holes	13	104	18	135	10	10	155
Total	18	128	26	172	10	11	193

TABLE 11—FIELDS* DISCOVERED IN 1944, 1947, AND 1950, GROUPED ACCORDING TO THEIR TOTAL ULTIMATE RESERVES AS ESTIMATED JANUARY 1, 1951

	Number of fields discovered in year indicated by reserve groups†								
Year	A	B	C	D	E	F	Total A—F inclusive	A+B+C fields	Percentage of A+B+C fields in total fields
1944	4	3	17	60	131	25	240	24	10.0
1947	4	6	14	55	166	36	281	24	8.5
1950	3	3	12	79	398	9	504	20	4.0

*This table refers only to the states of Alabama, Arkansas, California, Colorado, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Montana, Nebraska, New Mexico, Oklahoma, Texas, and Wyoming. It does not include gas fields unless natural-gas liquids are produced, and then the reserves figure relates only to these liquids. A few fields were omitted because of inadequate estimates, and a few producing areas, at first thought to be new fields, have become consolidated with other fields.

†In this table, A means 50 million barrels or more, B means between 25 and 50 million barrels, C means between 10 and 25 million barrels, D means between 1 and 10 million barrels, E means less than 1 million barrels, F means abandoned.

TABLE 12—EXPLORATORY DRILLING IN CANADA IN 1950

Province and well classification—	Oil		Gas		Condensate		Total prod.		Dry		Grand total	
	Number	Footage	Number	Footage	Number	Footage	Number	Footage	Number	Footage	Number	Footage
Alberta:												
Outposts	17	66,090	0	0	0	0	17	66,090	14	51,456	31	117,546
New-pool wildcats	5	21,561	1	1,985	0	0	6	23,546	8	32,335	14	55,881
Deeper-pool tests	2	281	0	0	0	0	2	281	1	2,331	3	2,612
New-field wildcats	20	102,124	17	69,698	1	6,404	38	178,226	155	760,145	193	938,371
Total	44	190,056	18	71,683	1	6,404	63	268,143	178	846,267	241	1,114,410
British Columbia:												
New-field wildcats	0	0	0	0	0	0	0	0	8	31,329	8	31,329
Manitoba:												
New-field wildcats	0	0	0	0	0	0	0	0	6	21,468	6	21,468
New Brunswick:												
New-field wildcats	0	0	0	0	0	0	0	0	2	9,259	2	9,259
Ontario:												
Outposts	1	483	0	0	0	0	1	483	5	3,924	6	4,407
New-pool wildcats	0	0	0	0	0	0	0	0	1	2,000	1	2,000
Deeper-pool tests	0	0	2	250	0	0	2	250	1	52	3	302
New-field wildcats	0	0	2	3,961	0	0	2	3,961	48	73,194	50	77,155
Total	1	483	4	4,211	0	0	5	4,694	55	79,170	60	83,864
Saskatchewan:												
Outposts	15	29,417	0	0	0	0	15	29,417	0	0	15	29,417
New-pool wildcats	2	3,769	0	0	0	0	2	3,769	2	3,556	4	7,325
New-field wildcats	4	9,822	0	0	0	0	4	9,822	63	143,880	67	153,702
Total	21	43,008	0	0	0	0	21	43,008	65	147,436	86	190,444
Total:												
Outposts	33	95,990	0	0	0	0	33	95,990	19	55,380	52	151,370
New-pool wildcats	7	25,330	1	1,985	0	0	8	27,315	11	37,891	19	65,206
Deeper-pool tests	2	281	2	250	0	0	4	531	2	2,383	6	2,914
New-field wildcats	24	111,946	19	73,659	1	6,404	44	192,009	282	1,039,275	326	1,231,284
Grand total	66	233,547	22	75,894	1	6,404	89	315,845	314	1,134,929	403	1,450,774

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GEOPHYSICAL FRONTIERS

by George E. Wagoner*

GEORGE E. WAGONER

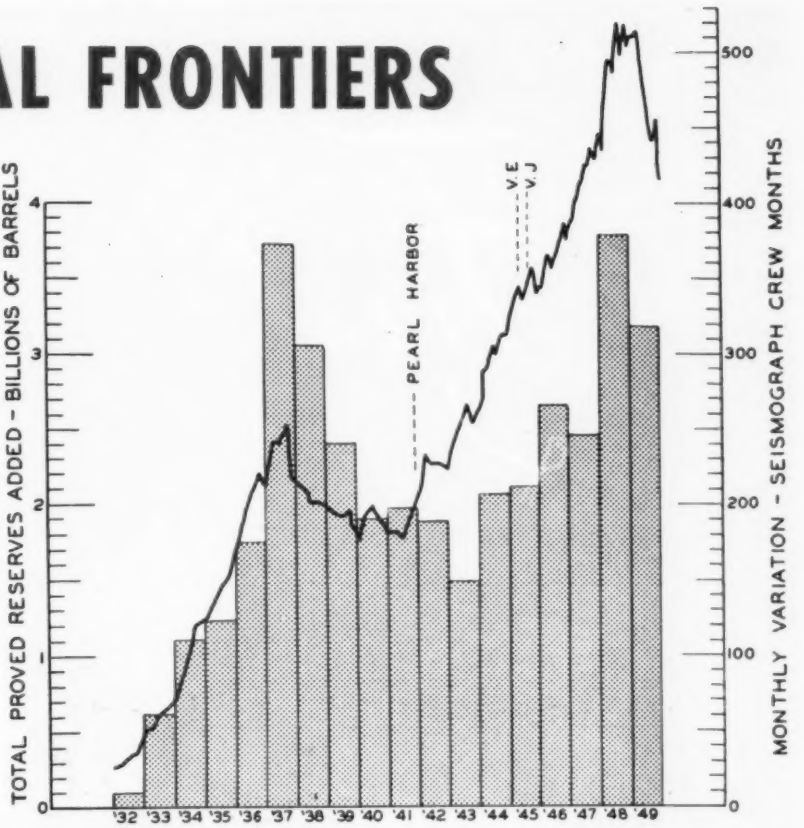

Fig. 1—Comparison of discoveries and seismograph activity in the United States.

IN the years 1920 to 1940 there was in the United States a vast frontier of undeveloped area to challenge geophysics. A great unexplored reserve of oil traps awaited the enterprising geophysicists who first brought their scientific devices to these strange lands. Through those early years, there was always new acreage for everybody interested; it was only necessary to stay away from, or keep ahead of, the competition. It was a lush period of easy, ready exploration. The geophysical frontier was the virgin area.

Geophysical prospecting for oil had started in the United States in the early twenties. The torsion balance found Nash Dome in 1922, and the new-fangled refraction seismograph, used as early as 1921, resulted in the famous discovery of Orchard Dome in Texas. The future kingpin of geophysics, the reflection seismograph, found Maud pool of Oklahoma in 1927. The magnetometer was first used in the early twenties in the search for oil. Electrical methods were well advanced in the late twenties. Electrical logging started as early as 1925, and geochemical methods were developed in the thirties. The great race was on.

In the first flush of the game, the bag was fabulous. Forty-four salt domes and structures were found in Texas in 1930 alone. Great oil companies were founded on these successes. Oklahoma was revitalized in the first great sweep of reflection parties. Illinois, long dormant, was kindled into a new oil area by the spreading exploration, and 200 new pools were found in the period 1936 to 1943.

Kansas felt the impact as crews concentrated on its Barton Arch. Undreamed-of structures in the old oil areas of Arkansas and Louisiana were dragged into man's knowledge by the probing geophysical tools. There 85 geophysical discoveries were made in the 10 years following 1936. A similar campaign engulfed the California basins. The vast western plains of the country, last to fall, responded to the wiles of geophysics.

Honeymoon Is Over

Today, this honeymoon is over. There are few new areas to beckon. Fig. 2 shows that a high percentage of the promising petroleum area of the United States has been shot. Some areas have been seismographed more than 20 times. The areas shown have been shot by many competing companies, and some areas have been shot and reshot by the same company. The repetition by the same companies has been caused by desire for closer coverage, engineering developments such as the automatic volume control, and new techniques. The repetition indicates that reserves have been overlooked, and that closer inspection is profitable.

But only a small amount of marginal virgin area remains. Is it all over for geophysics? Obviously not. There are now more reflection parties operating in the United States than ever before. The membership of the Society of Exploration Geophysicists has grown to 2,700. There is no letup in geophysics. Where, then, are the greener pastures?

The greener pastures lie in new frontiers. They offer an equal or greater amount of promise. But where the old frontiers were geographical, the new ones are technical.

It takes an enterprising boldness and courage to explore where others have been before; you take a calculated risk that you can explore better. Why do members of the oil industry take these risks?

For one thing, we have a frontier for new ideas. There are alert minds constantly at work on technical improvements to instruments. I refer you to the tremendous numbers of geophysical patents reported in Geophysics in the last 14 years.

There are alert minds constantly at work on interpretational problems. Our early enthusiasm for the closed contour has turned to the imaginative exploitation of obscure or well-

*Exploration manager, Southern Division, Carter Oil Co., Shreveport. Wagoner, retiring president of the Society of Exploration Geophysicists, presented this address on April 24 at the joint meeting of the A.A.P.G., the S.E.G., and the S.E.P.M. in St. Louis.

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hidden oil traps. One result of this is the "sweeping up," in our bag, of many small oil pools, and I refer you to the proposition that geophysically the big ones are far easier to find than the small ones.

I suspect that there are many technical minds at work on entirely new geophysical methods, and certainly the possibility of such developments enters into our consideration of frontiers.

Right now, a frontier of coordination of geology and geophysics is paying big dividends. No longer are these sciences separately pursuing the problem of discovery from different angles. Often inseparable, they now combine forces, dedicated to the fundamental idea that the putting together of all the data, both geological and geophysical, will tell you far more than any single method of attack.

I should like to define further these frontiers for you as they apply to our geophysical methods.

As far as virgin areas are concerned, these lands lie mostly outside the United States. When they become of interest, or become available, these lands are now quickly covered. For example, I refer you to the incredibly rapid coverage of the vast areas of western Canada initiated by the geophysical discovery at Leduc in late 1946.

Frontiers by Methods

Let us consider the frontiers of the several geophysical methods available to us.

Magnetics.—The frontier of magnetic surveys lies in interpretation. The airborne magnetic data now available provide magnetic pictures of such great accuracy and detail that tremendous strides in interpretation may be expected. By constant checking of magnetic data, both new and old, with new subsurface, seismic, and gravity data, we may expect to find important clues to structure manifested. One example might be a stratigraphic trap along the trend of a magnetic flexure.

Gravity.—The frontier for gravity surveys is very similar. Meters of great accuracy are today available, and interpretive techniques are progressing. Files packed with gravity surveys must be constantly reinterpreted along with development to be truly useful. An accurate survey already completed may be much more valuable in 10 to 20 years. Another gravity frontier lies in density measurements at depth. The relationship of density to porosity is well known, and certainly one frontier of gravity methods lies in the accurate knowledge and interpretation of density contrasts.

Electrical methods.—The frontier of electrical methods, for surface work, still lies in the experimental development of exploration techniques. In electrical logging, the frontiers have already expanded rapidly, and a great new field for application of quantitative interpretations of electric logs is opening up. Here the geophysicist has made an outstanding contribution to the recognition of reserves once the wildcat well is drilled.

Geochemical methods.—A vast frontier lies open and relatively unexplored for geochemical methods. It lies in the chemical analyses and correlation of oil shows, in the analyses of formation waters, and in the analyses and chemical correlation and mapping of geological formations. Rich rewards await the determination of the origin and source beds of oil, and earth chemistry may achieve this goal.

Seismic.—In spite of its universal employment, and of the widespread seismic coverage we have considered, the seismograph still offers the greatest frontier for geophysical methods. The first frontier lies in interpretation of seismic results. Here again our files are full of seismic records which probably have been interpreted by only one man and at the most, by two.

These interpretations may have been made years ago. If they had been absolutely complete and correct interpretations, most all our oil would by now have been found, considering the seismic coverage picture. But it hasn't, and for that reason the seismogram should be constantly reworked along with subsurface development and the determination of regional velocity changes.

Regional seismic maps should be made on all possible horizons. These regional maps should be supplemented with subsurface geologic maps in areas which have not been seismographed. Isopachus maps of zones significant for local areas should be kept up to date. No better method could be used for the discovery of stratigraphic traps.

E. A. Eckhardt last year stated, in his annual review of geophysical activity before this convention, that petroleum reserves discovered per year are proportional to the number of seismograph crew months. This is well shown by Fig. 1. The point of no return will be reached in reflection methods, as it was in refraction methods, unless the methods used are constantly improved by ingenious application and greater accuracy.

For example, study of records in connection with velocity variation factors may lead to the discovery of isolated sand bars, shoe-string sands, and to reefs. One contractor has been highly successful in finding shoestring sands in this manner in northern Oklahoma. Detailed studies of velocity variations may also lead to considerable structural variation on the interpreted map.

Continual care should be taken in field technique. Special seismic shooting methods should be tried in "NR" areas, which constitute local frontiers. Methods such as multiple geophones, multiple shots, air blasting, variation in shot-hole depths, and spread variation and pattern may all be expected to contribute unexpected results. Use of these techniques may appear to raise the cost per seismic profile. However, nothing is more expensive than an NR profile.

Experienced interpreters should be ever present with the field party to help the observer obtain the proper results.

I believe the future seismograph recorder will be one capable of recording all seismic movements set off by the blast or other outside energy source. Seismograms so obtained may be "played back" through amplifiers of different types until the optimum record is obtained. At least one contractor is developing such a recorder and has given demonstrations.

One aspect of the seismic frontier is the universal application of contin-

Fig. 2—Cumulative seismograph coverage in the United States.

uous profiling, replacing the older "spot" or correlation shooting. The use of continuous profiling will continue as greater detail is required, as will the use of closer spacing of geophone locations. The method may be dangerous in the hands of inexperienced interpreters, and this is often indicated by maps whose contours change with the direction of the line of profiles.

The seismic frontier is advancing rapidly, and it is probable that many other advances in field interpretation and technique have been made by companies and contractors which at the present time are confidential. The seismograph field is highly competitive, and there have resulted many advances in equipment such as, for example, 24 or 36 trace records. The competition has also resulted in improvement of field techniques to speed up operations so that more profiles may be obtained per day. This, of course, is also dangerous, since many reflections have been left behind with speed in mind.

Collectively, a very vital frontier is laboratory and field research. Difficulties encountered in many areas when using geophysical methods, as well as the limitations encountered, make imperative continued research on geophysical methods. Any company using old or outdated geophysical methods is badly handicapped, and its chances of success are limited.

Interpretation

In most all the geophysical methods discussed, the number one frontier is interpretation. Who are the ones to make these interpretations? In no other endeavor is experience more essential. In geophysics these interpretations must be made by men with years of experience. You cannot develop a good interpreter by teaching him how to compute continuous profile records or remove regional dip from a gravity map.

The interpreter should have a geological background, and he should be familiar with field conditions so that he may assist the operator in obtaining the best seismic results and in getting the best weathered layer correction. The interpreter must have a firm grasp of geology coupled with initiative and constructive imagination. This type interpreter is hard to find. Probably 10 or 15 trainees will be employed and trained before 1 good interpreter is developed. A continual stream of new talent should be employed to develop the "know how" interpreters to replace those who make the grade and move upward and to replace those who never make the grade.

This again sounds expensive, but what is more expensive than the wrong interpretation of data, which costs the industry millions of dollars in dry holes?

I believe that the oil industry recognizes these frontiers. In this country, during 1950, between $6,000,000 and $7,000,000 was spent on geophysical research alone. We must suppose that at least a portion of this was spent in an effort to locate some basic new approach, or a direct method of finding oil. The vast majority of it has been, and will continue to be, expended on these important frontiers within the old tried methods of geophysics. I believe, however, that if there exists a new basic approach, industry will find it. But as Ira Cram stated at the Fort Worth regional meeting, "We cannot afford to wait."

In conclusion, the record of the immediate past, including 1950, indicates that adequate future reserves will be discovered by present geophysical and geological methods. Across the frontier, as always, success will lie for the careful, for the exacting, and for the ingenious operator.

Acknowledgment

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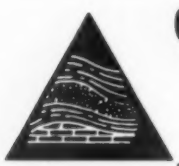

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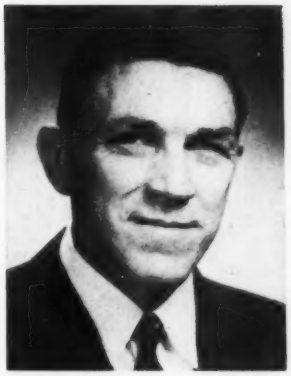

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EXPLORATION SOCIETIES' ANNUAL MEETING

Digests

Here are digests of many of the papers presented before the annual meeting of the A.A.P.G., the S.E.G., and the S.E.P.M. held at St. Louis, April 23-26

North American Geosynclines And Continental Origin

MARSHALL KAY, department of geology, Columbia University, New York City.

GEOSYNCLINES are surfaces of regional extent that subside considerably during formation of their included surficial rocks; they have limits of space and time. Early Paleozoic North America had a stable central shield (the hedreocraton) margined by deeper sinking belts (miogeosynclines) receiving carbonatites, and quartz arenites derived from the hedreocraton. The traditional long enduring "borderlands" of pre-Paleozoic crystalline rocks on the continental margins are untenable.

The continental borders have thick sections, principally of argillites, graywackes, conglomerates, and volcanic flows and fragmentals, but with preponderance through long times over large areas of carbonatites and cherts; they were laid in subsiding trenches adjoining ephemeral volcanic and tectonic islands geomorphically and genetically like modern island arcs.

Terrigenous detritus from lands raised in eugeosynclinal belts spread into the miogeosynclines and subsequently into subsiding borders of the hedreocraton (exeogeosynclines such as contain Upper Ordovician, and Middle and Upper Devonian in Pennsylvania and its surroundings, and the later Cretaceous of the Rocky Mountains and western Great Plains). The craton had elliptical geosynclines isolated from source areas (as those containing Upper Silurian and Devonian in lower Michigan, and Mississippian in Illinois), and others gaining detritus from adjoining intracratonal uplifted highlands (zeugogeosynclines, such as have Pennsylvanian and Permian in Colorado and New Mexico).

Eugeosynclines became consolidated by orogeny and by intrusion of plutonic rocks. Deeply subsiding, relatively nonvolcanic troughs (epieugeosynclines as those bearing Carboniferous in the Maritime Provinces, and the Tertiary of California) were succeeded by fault-bounded depressions (taphrogeosynclines such as have Upper Triassic in the East). Eugeosynclinal belts finally became stable cratonal areas; they developed coastal plains passing marginally into coastal geosynclines (paraliageosynclines, as that with the Eocene of the Gulf Coast).

Plutonic rocks are represented widely in the pre-Paleozoic in North America; each part of the continent has in some past time been eugeosynclinal. The present thick-sialic continent grew by accretion of progressive thin-sialic eugeosynclinal belts. Sialic nuclei grew through orogenic consolidation of eugeosynclinal or island arc belts, formed at the expense of an originally universal simatic crust, relics being the ocean basins, the low cratons.

The nuclei coalesced into a single continental mass by earliest Paleozoic, when thin-sialic eugeosynclinal belts extended to the present continental margin. Stratigraphic evidence contradicts hypotheses that assume an original floating sialic block on surrounding and subjacent sima; the continent has developed through dynamic processes.

Observations on Quantitative Distribution of Oil Accumulations Found in United States, or Why Are Major Oil Fields Located Where They Are

CHARLES J. DEEGAN, Cummins & Brinkerhoff, consulting geologists, Fort Worth.

A STUDY of oil accumulations found in the United States to January 1, 1950, shows that a mere handful of fields, each containing 100 million barrels or more, have accounted for 40 billion barrels of oil, or nearly two-thirds of all the oil found to that time.

Obviously, oil is like such other commercial minerals as gold, silver, iron, nickel, copper, aluminum, uranium, etc., in that really rich accumulations are scarce, but account for the bulk of the commercial production.

These studies show that no particular geologic age seems to be specifically unsuited for any major oil accumulation, if it has a substantial sedimentary column. Furthermore, no particular type of structure or stratigraphic trap seems to be specifically excluded as a possibility. The reservoir rock may be sandstone, limestone, or granite wash.

Major oil fields have been found at various depths, but most of them are relatively shallow by present deep-drilling standards. There is some evidence that great depth may be unfavorable to their existence in sand reservoirs. But even this evidence is not conclusive.

The most significant evidence (in the author's opinion) is that the surface area of all the major fields in the United States adds up to less than 45 miles by 45 miles, or say less than a block seven townships square. With major oil accumulations so rare, yet covering such a comparatively small area out of the total area in all oil-producing provinces, it looks as though the key factor to their existence must be a strictly local condition.

Some very localized, but vitally essential variation in environment may be a logical reason. That prescription would explain why one trap in a district contained a major oil accumulation, while other nearby traps, apparently geologically similar, held either no oil or only a comparatively small accumulation.

Insistence on the apparent importance of the very localized variation in environment does not mean that the author discounts or precludes any theories or evidence about certain regional conditions being necessary for the accumulation of oil. These may or may not be correct. But even if they are 100 per cent correct, the quantitative data on oil accumulations rather insistently point at a still further very localized condition as being necessary if there is to be a major oil accumulation.

Commercially, a complete solution of the problem "Where Can a Major Oil Field Be Found? is not a necessity. The leverage factor on profits and costs from any improvement at all is so high that the problem offers a very attractive research project to the industry. If we could increase the ratio of major fields found from the past rate of something less than 2 per cent of all fields discovered to around 4 per cent of all fields discovered in the future, the effect on the economics of the industry would be enormous. Such a stride would just about cut the cost of finding, developing, and producing oil in half.

Chimire Field, Anzoategui, Venezuela

VERNER E. JONES, Socony-Vacuum Oil Co. of Venezuela, Caracas.

CHIMIRE field is located in the Greater Oficina area of the state of Anzoategui in eastern Venezuela. The field was discovered by Socony-Vacuum when Chimire 2 was completed in January 1948. As of January 1, 1951, about 104 wells have been drilled, resulting in a production of more than 21,788,000 bbl. and an average daily production of about 55,265 bbl. Proved area in the principal producing sand (L-4 of the Oligocene-Miocene Oficina series) aggregates about 9,000 acres and is about 10 miles in length and 3½ miles in width, with a productive structural flank against the fault trap of about 700 ft. Concessions within the field are held by Socony-Vacuum Oil Co. of Venezuela, Creole Petroleum Corp., and Mene Grande Oil Co., C.A., the latter operating Creole concessions as well as its own.

The discovery well was located on a combination of surface geology, gravity, structure drill, and reflection-seismic work, while subsequent development has been guided by seismic and subsurface data. Production is from sands in the Oficina formation (Oligocene-Miocene) and the Merecure (?) formation (upper Eocene-lower Oligocene). Tests indicate 36 potential producing sands in the Oficina and two in the Merecure (?), but to date production has been restricted to 21 sands in the Oficina and 1 in the Merecure (?). Exploration

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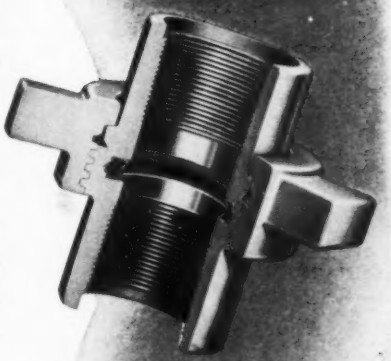

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Some Aspects of Reef Paleontology And Lithology in Edwards Formation of Texas

WILLIAM H. MATTHEWS, Texas Christian University, Fort Worth.

DETAILED lithology and paleontology of the two rudistid reefs in the Edward formation (Lower Cretaceous) are assembled with interpretations of classification and paleoecology of rudistid reef faunas.

On the basis of mode of preservation the reefs are divided into siliceous and calcareous groups. The best preserved fossils found in the Edwards are recovered from the reef facies, and those specimens from the siliceous reefs have undergone remarkable preservation. The shells of these organisms have been completely replaced by silica and may be studied in great detail.

Comparison between the calcareous and siliceous faunas shows that the variations are mainly due to slight environmental differences rather than to mode of preservation.

Field relations are the basis for suggesting that these rudistid reefs are tabular and should probably be called biostromes. These biostromes represent a special problem because they are essentially porous, organic concentrations entirely encased in limestone.

Paleoecology suggests that the reefs were deposited in a relatively shallow epicontinental sea. The waters were warm, clear, of normal salinity, and populated by an abundance of pelecypods, gastropods, and corrals.

Regional Devonian Stratigraphy In Wyoming-Montana-Southern Alberta Area

JOHN M. ANDRICHUK, Northwestern University, Evanston, Ill.

DEVONIAN strata occur throughout most of the northern Rocky Mountain-Great Plains area, except in eastern Wyoming and a relatively small area in adjoining southeastern Montana. The eastern edge of Devonian beds in Wyoming marks the approximate depositional limit. The western boundary of study in Montana is the edge of Devonian exposure marked by the appearance of prominent Laramide overthrust faults and by intrusions associated with the Idaho batholith. South Central Alberta is the northern limit of study.

The Upper Devonian exhibits a distinct areal variation in thickness and gross lithologic character. Several tectonic provinces can be outlined including: (1) Idaho basin, (2) shelf area of Wyoming and southwestern Montana, (3) east-west trending positive axis in central Montana, (4) "Alberta-Saskatchewan basin" situated in the northern part of area of study, and (5) elongate basin along southern part of Rocky Mountains of Alberta, trending slightly west of north. The lithologic characteristics are extensive evaporite deposits in southern Alberta and adjoining northwestern Montana. The "reef complex" facies of Central Alberta extends a considerable distance southward and apparently terminates north of the Princess area.

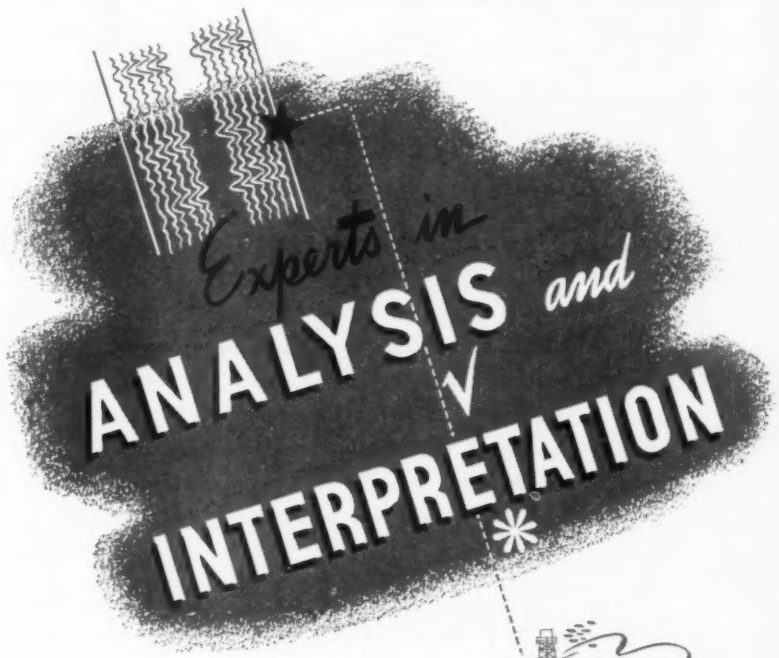
For purposes of analysis of the geologic history, the Devonian has been subdivided into four operational rock units: (1) a basal unit: "Basal Devonian unit" and "Dc" of Montana, Ghost River formation of the Alberta Mountain front, Elk Point formation and lithologic equivalents in subsurface of Alberta and Saskatchewan; (2) a lower limestone unit; limestone member of Jefferson formation, Fairholme formation (minus uppermost beds including Alexo silt), and lithologic equivalents in subsurface; (3) a dolomite-evaporite unit: dolomite member of Jefferson formation (plus evaporite-solution breccia zones in lower Three Forks formation), lower Darby formation equivalents, if represented, in Wyoming, Potlatch anhydrite, Morro member of Palliser formation (plus uppermost Fairholme beds including Alexo silt), and lithologic equivalents in subsurface; (4) an upper postevaporite unit: upper Three Forks formation, upper Darby equivalent, Costigan member in uppermost Palliser formation (as developed in Banff area), equivalent clastic and nonclastic beds between the top of the anhydrite and the base of the Exshaw in subsurface.

Isopach-lithofacies maps based on these units may be interpreted in terms of the tectonic and environmental pattern responsible for areal and vertical distribution of evaporitic and normal marine sediments. The resulting picture illustrates a method of approach toward an understanding of the reef complex and other problems at the northern edge of the area.

Oil Prospects of Israel

MAX W. BALL and DOUGLAS BALL, oil and gas consultants, Washington, D. C.

ISRAEL lies between the African-Arabian pre-Cambrian shield and the geosyncline



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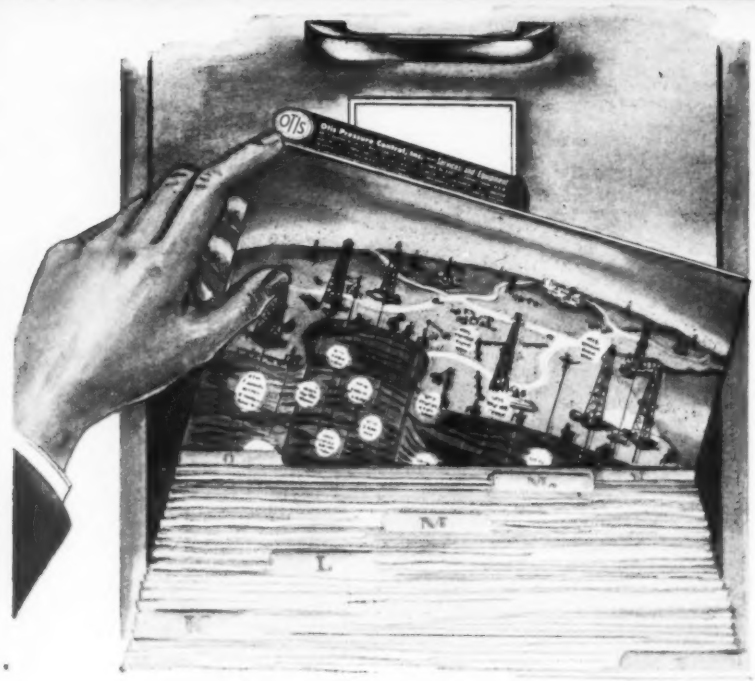

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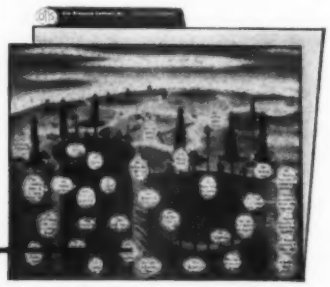

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of the eastern Mediterranean. Since Cambrian time the area has been a coastal region, with frequent ingressions and regressions of the sea. The result is a succession of interbedded bathyal, neritic, estuarine, lagoonal, lacustrine, and terrestrial sediments, with many breaks in the sequence. Wedgeouts and changes in facies are characteristic and commonly abrupt, excepting in the Upper Cretaceous beds, which are somewhat more continuous. Maximum sedimentary thickness is unknown, but may be 20,000-30,000 ft.

Eight geologic provinces make up the country: the Dead Sea-Wadi Araba graben, the Negev or southern desert, the coastal plain including the continental shelf, the foothills belt of Judea and Wadi Ara, the Carmel uplift, the Emek or Esdraelon-Harod Plain, the Galilee highland, and the eastern Galilee basin. Each is distinct from all the others in structural pattern.

Deformation ranges from low folds in the coastal plain and the foothills to rift zones bordering the Dead Sea-Wadi Araba and Emek grabens, tilted and scissored fault blocks in Galilee, and pronounced anticlines with picture-book domes in the Negev.

Asphalt impregnations and live seepages are numerous in the rifts near the Dead Sea; gas and asphalt eruptions in the Dead Sea itself have been famous since prehistoric time. Across the country in the coastal plain near Gaza is a gas seepage with asphalt impregnation and a sulfur deposit, and a water well near Sakia got a substantial flow of gas in Pliocene beds at 517 ft. Minor surface and near-surface evidences are present in other parts of the country.

Each of the tight geologic provinces has oil possibilities. The most promising are the Negev, the foothills belt of Judea, the coastal plain, and the Dead-Sea-Wadi Araba rift valley.

A well has been drilled in the coastal plain to 3,464 ft., through part of the Cretaceous, leaving 5,000-10,000 ft. of sediments undrilled. A few shallow wells have been drilled in the rift zone west of the Dead Sea. Except for these inadequate tests the country is virgin territory, waiting to be tested.

Salt-Ridge Hypothesis on Origin of Texas Gulf Coast Type Faulting

MILLER W. QUARLES, JR., United Geophysical Co., Houston.

THE salt-ridge hypothesis is presented for the origin of the unusual type of medium to low-angle normal faulting characteristic of the salt-dome province of thick Tertiary sediments bordering the Gulf Coast of Texas. This hypothesis states that a deep-seated vertical intrusion of salt in the form of a long narrow ridge pushes up the gulfward-dipping beds along their strike to form deep-seated anticlines. A normal fault pattern with dips of approximately 45° has to develop on every anticline as an adjustment for the vertical compression of the section. The term "edge syncline" is introduced for the depressions that may parallel the ridges as a result of salt removal.

Two other hypotheses are analyzed which currently enjoy some measure of acceptance: (1) subsidence of the basement rock toward the gulf, and (2) slipping of sediments downdip toward the gulf on a bedding plane.

The salt-ridge hypothesis is the only one of the three that adequately explains the following Gulf Coast fault characteristics that are found on seismograph sections: (1) medium to low angle of dip, (2) both up-to-the-coast and down-to-the-coast movement in same locality, (3) adjustment faults forming narrow grabens, (4) dipping down of beds into downthrown side of fault, (5) dipping up of beds under the upthrown side, (6) great increase of throw with depth, (7) rapid dying-out of faults laterally, (8) localized throw across fault with no relative displacement of beds a mile or more away, and (9) a decrease with

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depth in the amount of dip down into the downthrown side of the fault.

The presence of salt ridges would require that new concepts be used for locating deep oil fields. Favorable structures would be far more numerous than are now envisioned, and the location of test wells with respect to the basic anticline would be relatively simple.

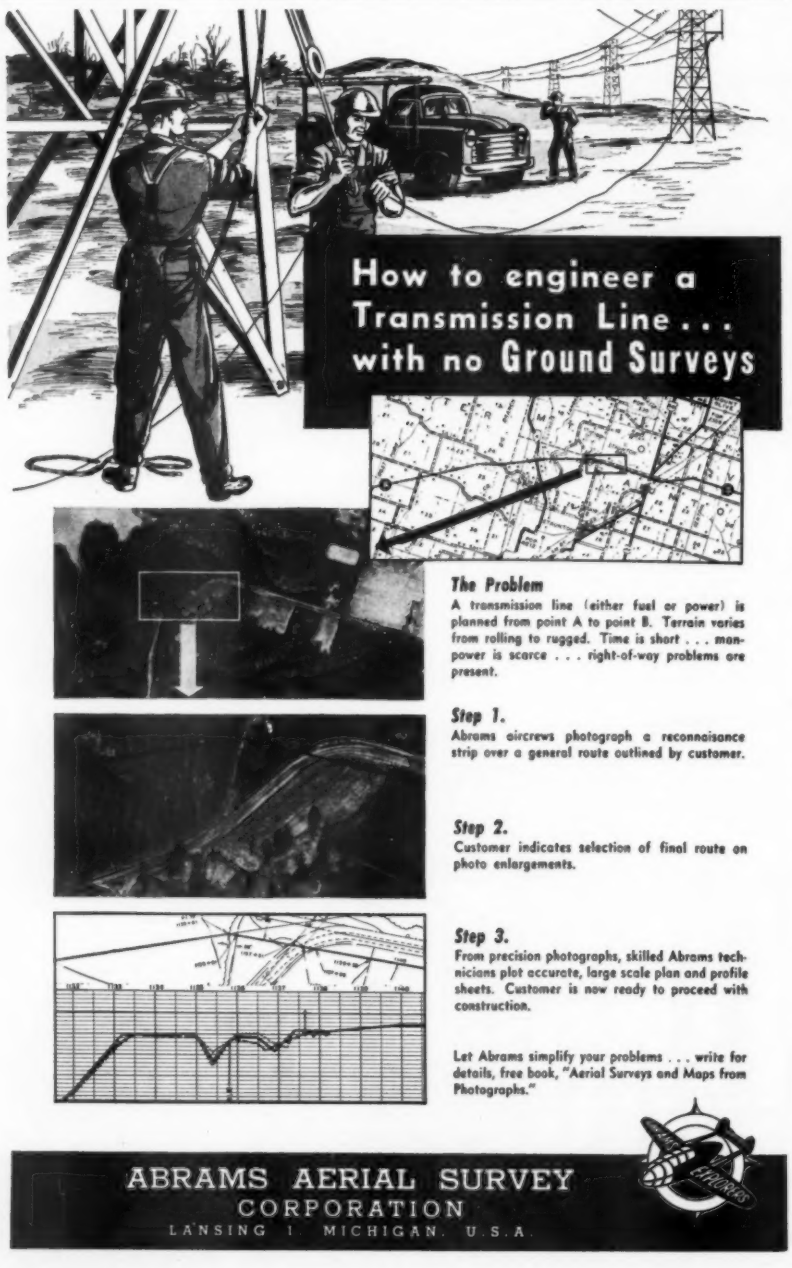
Gulf Coast Exploration Methods

FRED R. HAEBERLE, Standard Oil Co. of Texas, Amarillo.

EXPLORATION and discovery methods for 832 fields in the Texas Gulf Coast were examined. Gravity played a part in the discovery of 11 per cent of the total fields, seismograph in 43 per cent of the total, and subsurface methods aided in the discovery of 32 per cent of the new fields. Magnetic methods aided only in 1 per cent of the total discoveries, while the core drill assisted in 2 per cent. Surface methods were the other principal ones used. Reflection seismograph accounted for 218 fields, or 26 per cent of the total new fields, while subsurface methods alone found 184 new fields, or 22 per cent.

The combination of reflection seismograph and subsurface methods accounted for 143 new fields, or 17 per cent of the total. About 65 per cent of all the oil and gas fields in the Texas Gulf Coast were discovered either by reflection seismograph, subsurface methods, or their combination. The fields in this area were broken down into seven major structural types and the principal discovery methods for each type discussed.

Of these seven types, reflection seismograph has been most important in discovering two, while subsurface methods have been most important in exploring for four. Beyond their use in discovering salt domes, gravity and magnetic methods have not been too successful in this region. Approximately 80 per cent of all the fields in the Texas Gulf Coast have been discovered by use of the reflection seismograph, subsurface methods, and surface methods. Reflection seismograph and subsurface will probably continue to be the most important in the future.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Scale-Model Results as Guide For Geologic Interpretation Of Salt Structures

T. J. PARKER and A. N. McDOWELL, Texas A. & M. College, College Station.

THE techniques of construction of geologic scale models and the determination of scale-model ratios are briefly reviewed. The results of laboratory investigations of salt dome initiation are presented and compared with an area in the Gulf Coast. Fracture patterns developed by model domes are described. The application of these patterns in the analysis of salt structures is illustrated by detailed structural interpretations of three Texas domes of different depths to the salt top.

Depositional Environment Of Black Shale

PARKER D. TRASK.

BLACK shale is characterized by: (1) Shaly structure, commonly fissile or thin bedded, (2) very fine-grained size of constituent particles, (3) high organic content, (4) black or dark color, (5) uniform character throughout considerable areal and vertical extent, (6) absence, scarcity, or dwarf nature of fauna, (7) low content of calcium carbonate, relatively high content of iron sulfide, and varying quantities of phosphate and iron carbonate.

To account for these features the following inferences could be considered: (1) Deposition in a basin, marine or brackish, in which subsurface water is stagnant and is in a state of reduction, (2) long continued density stratification of water in basin, (3) orogenic quiet for material length of time, (4) narrow seaward outlet of basin, (5) shallow sill at outlet, or basin located in warm-temperature or warm climate, (6) intermediate depth of basin, but depth probably is not critical, (7) adequate replenishment of surface water to support abundant life, (8) warm-temperate and humid or semihumid climate, (9) relatively rapid rate of supply of terrigenous constituents, (10) high initial water content of sediments with resulting compaction of order of 90 per cent, (11) low relief of land adjacent to sea.

The stratigraphic relationships of black shale suggest deposition: (1) On the seaward rather than the landward side of geosynclinal basins, (2) at a time materially in advance of final orogenic destruction of the geosyncline.

Microfossils as Environment Indicators in Marine Shales

SAMUEL P. ELLISON, JR., Department of Geology, University of Texas, Austin.

INTERPRETATIONS of depositional environments from microfossils are based mainly on comparisons of the fossil suites with the microorganic remains in modern ocean muds. Qualitative comparisons of species, genera, and families common to both shales and modern sea muds have provided two broad generalizations. First, benthonic organisms are the chief indicators of temperature, depth, amount of light, water composition, and bottom conditions. Second, pelagic, planktonic, and nektonic organisms overlap into a variety of sedimentary environments indicating only broad latitudinal boundaries of temperature and salinity.

Quantitative studies of micropopulations provide the best data from which to reconstruct the environments of deposition.

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The quantitative methods also promise to be new stratigraphic correlation tools, their importance ranking with lithologic and mechanical logs. Microfossils are particularly amendable to quantitative treatment because the human element of field selection of specimens is reduced to a minimum.

Five important basic principles apply to microfossils if they are employed to determine environmental conditions. First, microfossils are integral parts of the lithology of shales. Since the specimens are particles of the sediments, then the fossils and the lithology should be considered a closely knit result of the whole environment. Second, specimens are derived simultaneously from the living (biocoenosis), the dead debris (thanatocoenosis), and agents of sedimentation (wave action, currents, turbidity currents, and mud slides). Third in the process of sedimentation, gravity moves all microorganic remains to deeper locations on the ocean floor. Consequently, the upper depth and temperature limits of living organisms are the keys to depth and temperature interpretations of the past. Fourth, the use of biological ecology data for comparisons with microfossil suites brings in only the biocoenosis elements. Fifth, geographic distribution and coordination of each microfossil suite to the paleogeographic setting are necessary to reconstruct the environment.

Petrographic and Lithologic Attributes of Sandstones

E. C. DAPPLES, Northwestern University, Evanston, Ill.

SANDSTONE are recognized as being one of the most sensitive recorders of changes of environmental conditions of sedimentary deposition. Subdivision into quartzose, subgraywacke, graywacke, and arkose major groups is already established, and each is acknowledged to be indicative of physical environments primarily established by the degree of tectonic stability prevalent in the depositional site; and secondarily controlled by the source area.

Uncertainty prevails concerning the interpretation to be placed upon petrographic and lithogolic characteristics typical of each major sandstone class. This paper is an attempt to systematize certain of these properties, statistically, to permit giving them proper weight in reconstructing the depositional framework.

Consideration of mineral constituents (> 10 per cent in abundance) reveals a relatively short list. Quartz, chert, chalcedony, potash and sodic feldspar, muscovite, biotite, chlorite, clay minerals, pyribole, glauconite, iron oxide, calcite dolomite, gypsum, carbonaceous fragments, and rock fragments including glass.

Mineralogic composition alone proves to be an insufficient basis for rational interpretation. Classification requires the interjection of sorting as a refining parameter. Difficulties are raised by attempts to treat both mineralogic and sorting attributes simultaneously.

Assemblage of data on the distribution of the foregoing properties of sandstones, plotted on triangle diagrams, shows a distribution of points which can be characterized by certain statistical parameters. These parameters provide a basis for more systematic interpretation of the tectonic implications or tendencies of sediments.

Correlation of Carbonate Rocks By Chemical Analysis

H. R. GAULT, ROSS H. LESSENTINE, Lehigh University, Bethlehem, Pa., and CARL WARMKESSEL, Lehigh Portland Cement Co.

ROCK-UNIT correlation by chemical analysis for guiding diamond-drilling programs and determining some structural detail has been used successfully in the exploration of limestone and dolomite deposits. The entire core or a split is analyzed at regular intervals or at obvious lithologic breaks. Drill holes are located to cut overlapping sections. Silica and magnesia or magnesium carbonate are the most useful constituents in correlating but lime or calcium carbonate, total iron and alumina are also useful.

The relative simplicity of procedure in chemical analysis of carbonate rocks and the industrial importance of carbonate rocks because of their chemical composition make possible a source of analyses which numerically probably surpass the aggregate number of all other rock analyses. Compilation of carbonate rock analyses in several types of petrochemical diagrams shows certain chemical and calculated mineral characteristics which are distinctive for individual formations and offer some promise in studying regional sedimentation and stratigraphic problems.

Examples of correlation within a single formation and involving several formations in small intensively drilled areas are given. The possible use of chemical characteristics over large areas is illustrated.

The use of chemical analyses for correlation is probably practicable only for carbonate rocks because of greater analytical problems with other rock types. The intent of the discussion is only to point out that chemical analyses are a possible correlation tool not yet given much consideration.

Use of Statistical Techniques In Paleontology, Sedimentation And Stratigraphy

W. C. KRUMBEIN, Northwestern University, Evanston, Ill.

STATISTICAL methods involve techniques used to obtain, analyze, and present numerical data. The methods are particularly applicable to geological problems, in which large masses of data are encountered, as in sedimentation and paleontology. The large number of variables inherent in most studies renders it difficult to express relations as simple functions. Hence, statistical techniques which aid in recognition of controlling variables are finding increasing use in these fields.

Statistical techniques include collection, assemblage, classification, condensation, graphic presentation, and mathematical analysis of data. The data may be grouped according to three main categories: (2) Frequency distributions are concerned with magnitudes, as the familiar grain-size analysis of sediments. (2) Time series are concerned with successions of events through time, and apply to studies of successive fossil faunas. (3) Spatial distributions are concerned with geographic or bathymetric patterns, such as paleoecological studies and facies mapping.

Special techniques applicable to those categories include statistical correlation, analysis of variance, problems of sampling, study of rates of change, probabilities of occurrence, and many others, which find application in a variety of paleontologic, sedimentary, and stratigraphic problems.

Thermoluminescence and Surface Correlation of Limestones

DONALD F. SAUNDERS, Department of Chemistry, University of Wisconsin.

NEARLY all limestones will emit light when heated to a temperature below that of incandescence. This thermoluminescence is a natural property of the calcium and magnesium carbonate minerals in the rock. It can also be artificially induced by irradiating specimens with gamma rays or X-rays. The natural thermoluminescence has been produced by radiation from radioactive impurities in the rock.

The light emission is measured by a photomultiplier tube circuit as the temperature of the specimen is increased. Both of these variables are recorded simultaneously by means of a two point potentiometer recorder. A plot of the light intensity as a

(Continued on page 186)

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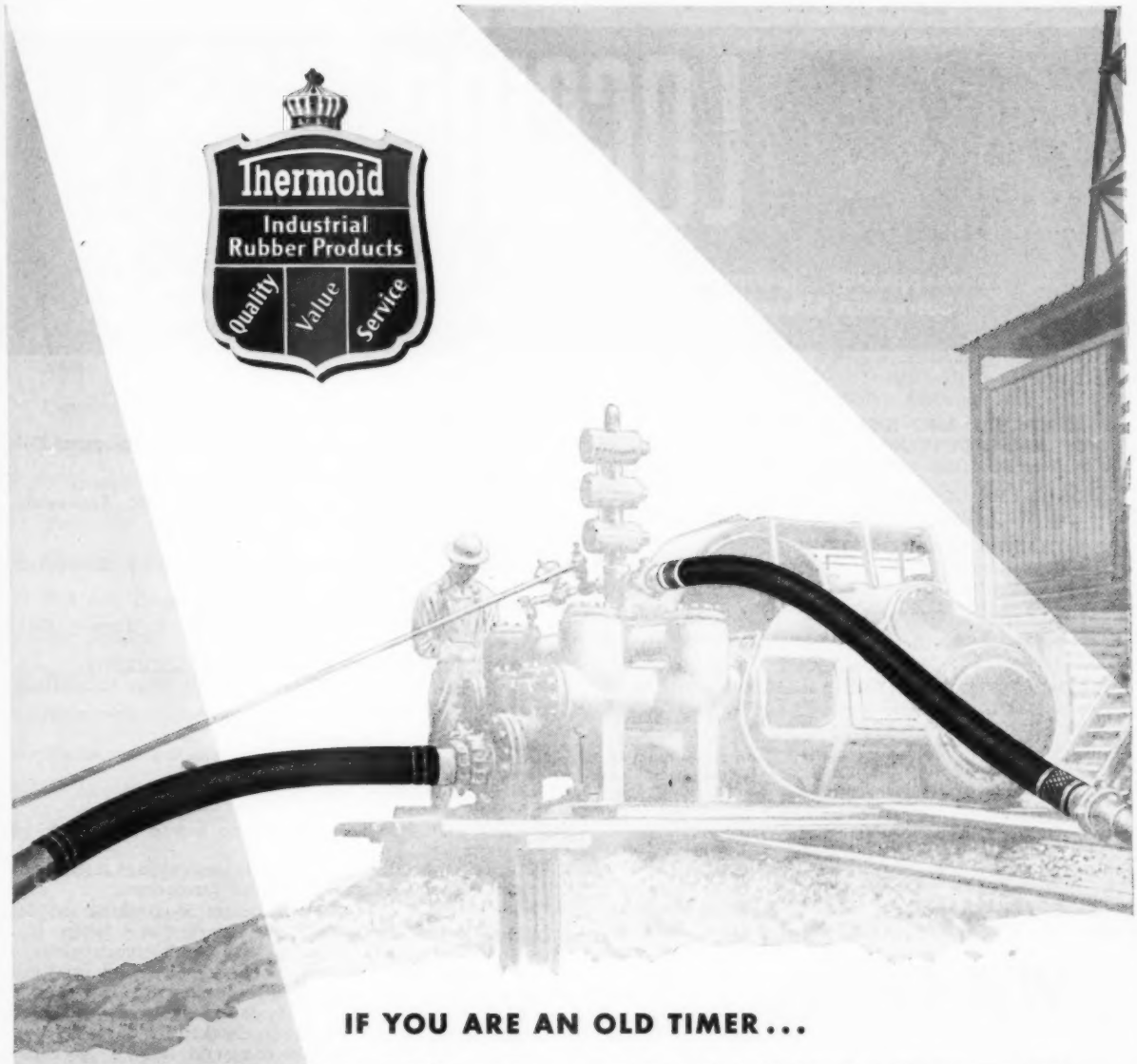

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This Oil and Gas Journal presentation is published by special permission from the Colorado School of Mines' monumental symposium entitled "Subsurface Geologic Methods" (1950). The book has 50 contributing authors and was compiled and edited by Prof. L. W. LeRoy of the institution's department of geology.

1. Sampling and Examination of Well Cuttings

MUCH subsurface geologic work depends on the collection of representative samples of the formation penetrated, describing these samples accurately, and plotting the description so that the sections in different wells may be correlated.

The collection and examination of samples of well cuttings are highly organized and important techniques. In fact, in many areas, well cuttings are the only reliable source of data concerning the formations penetrated.

Of all the methods of obtaining information concerning rocks cut by the drill, cores are probably the most reliable. In soft unconsolidated formations these cores can be taken rapidly and with comparatively little expense, by means of a wire-line core barrel. However, in areas where most of the rocks are well lithified and many are extremely hard, wire-line core bits wear out rapidly, and cores are usually obtained by use of conventional core barrels which are capable of cutting a maximum of 20 ft. at one time. This makes complete coring extremely expensive, especially in deep holes.

Recently a new technique of coring with diamond-studded core heads has been developed which may lead to much more extensive coring. It is possible that in the future as much as 100 ft. of core may be taken at one time by means of a diamond bit without coming out of the hole. This may render practicable coring of complete sections of deep holes.

Cable-Tool Samples

The collection of cutting samples from cable-tool wells presents comparatively few difficulties. The samples should be collected from the first bailer after each run of the bit, in a bucket hung at the end of the dump box. These samples should be washed enough to carry off all mud. They should be put in cloth sacks, then labeled with the name of the company, name of the farm, number of the well location, and depth of sample. The hole is, of course, bailed clean each run of the bit, and only occasionally are cavings a problem in consolidated formations.

The problem of checking the depth at which samples are taken is not critical with cable tools, since the depth is checked by sand line on the bailer after each run. However, important datum beds in the section should be checked for depth by stringing in the sand line or by running a steel measuring line. Cable-tool samples differ from rotary samples by the general flaky character of the harder formations and by the polishing and rounding of many cuttings from attrition due to turbulence set up by the bit, and the irregular intervals at which they are taken, since the length of bit runs are determined by the character of the formation and mechanical factors.

Rotary Samples

The collection of rotary samples presents many more difficulties than the collection of cable-tool samples and for many years it was considered impossible to obtain reliable samples by this method of drilling. It is still difficult to obtain representative samples from rotary holes in unconsolidated formations, but a technique has been worked out whereby representative samples can be obtained in consolidated formations. These samples are taken from the returning fluid stream at regular intervals. The sample interval is usually 5 or 10 ft.,

Standard Symbols for Maps and Logs

WELL SYMBOLS

- Derrick
- Abandoned derrick
- Drilling well
- Drilling well suspended
- Abandoned drilling well
- Abandoned drilling well with oil show
- Oil producer
- Shut in or suspended oil producer
- Abandoned oil producer
- Well with gas show
- Gas producer
- Shut in or suspended gas producer
- Abandoned gas producer
- Abandoned gas well with gas show
- Oil and gas producer
- Abandoned oil and gas producer

SUBSURFACE OIL, GAS, & WATER SYMBOLS

Red
- Gas, small amounts
- Gas, strong showing
- Oil smell, faint
- Oil smell, pronounced
- Slight oil show
- Good oil show
- Oil & gas show

Blue
- Fresh water
- Salt water
- Flowing fresh water
- Flowing salt water

Black
- Producing oil sand
- Producing gas sand

but may be as small as 1 ft. or as large as 30 ft. The chief problems in collecting samples of rotary cuttings are to prevent contamination with upper beds, prevent powdering of the sample, prevent loss of the sample, prevent elutriation, obtain correct depth measurement, and wash and properly dry the samples.

Contamination from upper beds.—This is the chief problem of collecting rotary samples. In the early days of rotary drilling before mud building was fully understood, the walls of the hole were poorly plastered and unstable. Thus, the samples contained large amounts of extraneous material. The practice of considering any new material appearing in the samples as composing the entire content of the formation drilled then became general and any other material was believed to be cavings. At present, however, the treatment of rotary muds has advanced so that usually a properly mudded rotary hole caves very little and the percentage content of the sample may be taken as representative of the types of rock in the interval covered. This enables the geologist to follow very closely the lateral gradations in the section.

Powdering of cuttings.—The powdering of the sample to a size too small to be examined effectively under the binocular microscope is largely due to poor mud which allows regrinding of the sample by the bit and powdering by whipping of drill pipe against the walls of the hole. When extraordinarily large cuttings are needed for analysis of porosity and permeability or for other purposes, it is helpful to circulate in reverse of the usual manner, that is, to pump the mud down between the casing and drill pipe and up through the drill pipe. This process results in higher mud velocities returning through the drill pipe which brings larger cuttings from the bottom as soon as they are chipped off by the teeth of the rock bit. Some of these cuttings are ½ to ¾ in. across.

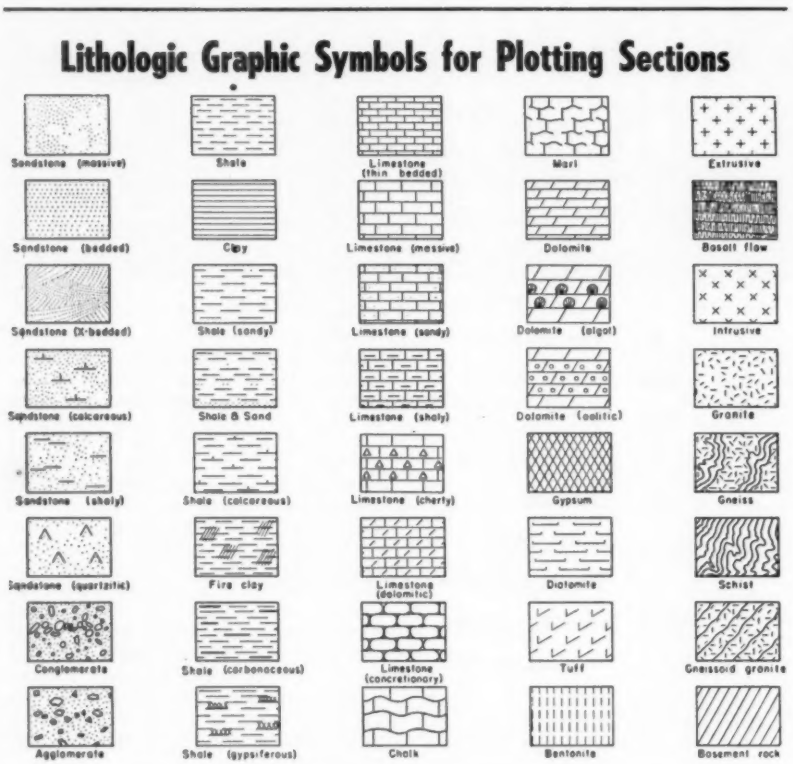
Reverse circulation is especially useful when drilling into low-pressure formations, by using oil as drilling fluid, as it prevents any of the fine oil-borne cuttings from plugging the pores of the formation. In regular circulation with oil, the low viscosity of the oil will not carry out the cuttings, and they are commonly reground to a fine putty-like mass which is useless for examination and has a plugging effect on low-pressure pays. Of course, reverse circulation is not necessary in high-pressure gas or oil pays since the high pressures tend to increase the velocity of the circulating fluids and carry the cuttings out of the hole. The advantages of using a water-free drilling fluid in low-pressure oil pays are combined with the advantages of a high-viscosity mud in carrying out the cuttings and cleaning the formation in oil-base muds recently developed. With these muds it is not necessary to use reverse circulation to obtain cuttings large enough for visual examination. However, since methods have been recently developed for determining porosity and permeability from extra-large cuttings obtained by reverse circulation, this method undoubtedly still will be used to some extent in pay sections.

Loss of cuttings.—Loss of cuttings samples is due to two chief causes: lost circulation, and blowouts. Both of these are primarily mud problems. Lost circulation is caused either by too high water loss in the mud or by excessively heavy mud which overcomes the formation pressure of a porous or fractured bed so that the mud enters the pores or fractures. The cuttings are then carried into the porous beds and may not ever be recovered unless the well is completed in this zone and the cuttings come out later with the oil. Blowouts are caused by unexpectedly high formation pressures or by carelessness in handling the mud. The cuttings are blown out of the hole and not recovered.

Elutriation.—Elutriation or separation of the coarse from the finer part of the sample by the upward movement of the circulating fluid is due to the use of mud with low viscosity and gel strength. In good mud the cuttings are held in suspension and there is little change in the relative position.

Obtaining correct depths.—Obtaining proper depth measurement for rotary cuttings is another major problem. The depth of the well must be checked often either by steel measuring line or by measuring the drill pipe under tension. Attention must be given constantly to see that the crew catches the samples at the proper intervals and that they do not anticipate the sample by filling several sacks at one time.

In pay sections where the exact measurements are very important or in deep holes where the cuttings take a long time to come to the surface, samples should be labeled with the depth at which they are actually cut rather than the depth of the well at the time they come to surface. This measurement is accomplished by placing some easily identifiable substance, such as rice or corn in the drill pipe at the derrick floor when making a connection, and measuring the time required to bring the substance around to the shale shaker or return pipe. If regular circulation is being used, it can then be calculated from the pump pressure and volume handled how long the mud requires



to go from the derrick floor through the drill pipe to the bit, and this subtracted from the total return time gives the time necessary for the samples to come from the bit to the surface.

Unless it is known that the hole is in extraordinarily good shape with no washed-out places, it is not satisfactory to calculate the return time from the bit by mud volume and velocity, because some eddying and consequent lowering of the mud velocity takes place in all washed-out places. If it is not possible to determine the sample return time from experimental methods of calculation, a rule of thumb is that under ordinary mud pressure with 7 or 8-in. hole, it will take cuttings about 10 minutes per 1,000 ft. to return from bottom.

Catching samples.—There are many ways to catch representative samples from the returning mud stream. The rotary shale shaker has become very common in recent years. This is a large cylindrical screen through which the returning mud stream passes. The screen is turned by a water wheel moved by the mud stream. Attached to the large screen is a much smaller screen with fine mesh through which a portion of the main mud stream is diverted, off which comes a small portion of the cuttings which is collected in a box at the end of the screen for visual examination.

Another important type of screen commonly used is the vibratory shaker. In this device the mud stream passes across a vibrating screen. The mud passes through the screen into the pits while the cuttings are vibrating off into another receptacle. In consolidated formations good samples can be taken by placing a narrow box under a part of the end of the vibrating screen so that a representative portion will fall into this box.

The simplest and possibly most reliable sample-catching device (Fig. 1) consists of a small-diameter nipple welded to the bottom of the mud-return line with a 1½-in. or 2-in. line running to a box 1 ft. by 1 ft. by 3 ft., with a removable gate about 6 in. high in the end. In this box a representative portion of the cuttings is collected and may be shoveled out at the appropriate time into a bucket and the box cleaned by removing the end gate and letting the mud stream carry out the remaining cuttings. When these are washed away, the gate is replaced and the collection of the next sample is begun. By this means a representative portion of both the fine and coarse parts of the cuttings is obtained.

After the samples are caught, they must be washed properly. This can be done in a bucket by filling it partly full of water and stirring the samples vigorously, letting the clean part settle and decanting the fluid several times until the water is clear and the sample is ready for sacking and labeling. Sometimes the sample is washed in a box with a fine-screen bottom. This hastens the washing process, but there is some danger of losing the fine sand from the sample. When drilling with oil or oil-base mud, one must wash the sample entirely free of drilling fluid before it is dried. This can be accomplished by using hot water, although some prefer washing with kerosine or gasoline before washing with water. One need have no fear of washing the indigenous oil stain and saturation from the sample as any ordinary washing will only remove the drilling oil and will not remove the natural oil from the formation.

After washing, samples are commonly dried artificially. However, in samples showing stain and saturation this must be done with extreme caution as overheating will blacken the natural-oil stain and mask the

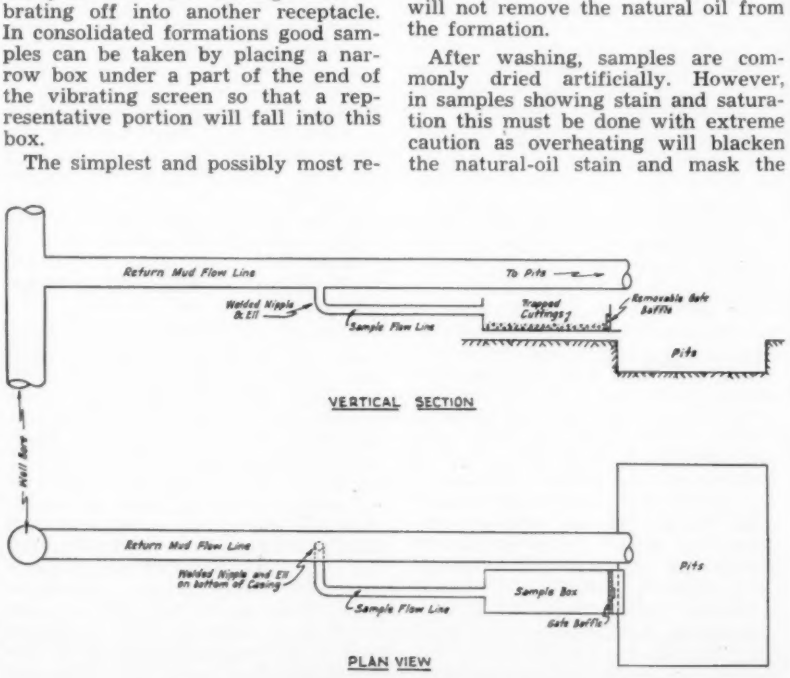


Fig. 1—Diagram of simple sample-catching device.

Standard Symbols Used in Reservoir Mapping

Oil Producing Horizon

Gas Producing Horizon

Tested Oil

Gas Input well

Tested Gas

Tested Condensate

Tested Water

Interpreted Oil

Interpreted Gas

Interpreted Water

Non-Productive or non-commercial test

Tested Oil and Gas

Tested Oil and Water

Interpreted Oil and Water

Former producing horizon

Former producing horizon, now gas input

Interpreted non-productive or non commercial

porosity as well as render it difficult to tell whether the formation fluid is oil, gas, or water.

Examination of Cuttings Samples

Samples may be examined while covered with water. This method brings out by differential refraction some of the qualities of the sample such as oolitic structures and anhydrite crystals which may be overlooked in dry samples.

Cuttings samples ordinarily are examined under a binocular microscope of low power (12 to 24). Higher powers are used for special purposes such as the description of minor features of microscopic fossils. It has been found that the white light given by the fluorescent lighting tube is much superior to the yellowish light of the incandescent bulb. This is especially true when searching for oil stain in the cuttings, since the yellowish incandescent light commonly masks the light-brown oil stain. In examining samples for oil stain and saturation it may be desirable to use an ultraviolet light.

There are two principal ways of describing samples. The first of these is the interpretative system, in which the geologist picks out the cuttings which he believes to be representative of the formation penetrated and describes the entire sample as composed of this rock. The rest of the sample is assumed to be cavings. This kind of description brings out formational changes and is of greatest value in areas where the various formations are of wide extent and relatively constant character, as in the Paleozoic of the Mid-Continent region. In areas of rapid lateral gradation in the lithologic character of formations, as in the Permian basin of West Texas, this method results in masking of lateral variations and misinterpretation of the nature of the stratigraphic column. This, of course, results in miscorrelation of the well logs.

In regions of pronounced lateral gradation it has been found that a second method of sample description is most satisfactory. This is the percentage description, where the geologist describes all material in the sample, disregarding obvious foreign substances and cavings. This system, though making it difficult to determine formational boundaries from the sample log, shows the gradations of the beds and often enables one to trace a horizon through different sedimentary facies.

The descriptions may be written out or plotted directly on a log strip. For many purposes, it is desirable to make written descriptions, since the logs can be plotted in several places at the same time and a record is kept which is not subject to destructive wear as is the plotted log which is used constantly in the field and laboratory.

Color of the rock fragments in cuttings samples is a very important attribute. At present there is a wide variation in the descriptions of color by subsurface geologists. The same rock may be described as tan by one and brown or gray by another. It is desirable in any organization attempting to start sample examination work to standardize some color scheme, possibly that being developed by the inter-society committee.

Size of particles in dolomites and limestones is another matter on which subsurface geologists vary. The following table gives the tentative scale of crystal sizes which was developed by the West Texas Geological Society several years ago.

TENTATIVE SCALE OF CRYSTAL SIZES IN DOLOMITES AND LIMESTONES

Descriptive adjectives	Crystal diameter
1. Mat	Invisible
2. Microcrystalline	Less than 10 mm.
a. Cryptocrystalline	Less than 0.02 mm.
b. Finely crystalline	0.02 to 0.1 mm.
c. Mediocrystalline	0.1 to 2.0 mm.
d. Coarsely crystalline	2.0 to 10 mm.
3. Megacrystalline	

Definitions

Mat—Compact, exceptionally homogeneous; having a dull but even surface under low binocular microscope; resembling limestones used in lithography; as, a mat limestone, a mat dolomite.

Microcrystalline — Having crystals less than 10 mm. long; having crystals small enough to be viewed under low-power binocular microscope.

Cryptocrystalline—Indistinctly crystalline; showing very small, indistinct crystal faces; composed of crystals too small to be measured under low-power binocular microscope.

Megacrystalline—Having crystals 10 mm. or more in length; having crystals too large to be readily discernible under low-power binocular microscope.

Porosity, permeability, and oil stain. Description of the porosity, permeability, and oil stain of cuttings samples is one of the most important

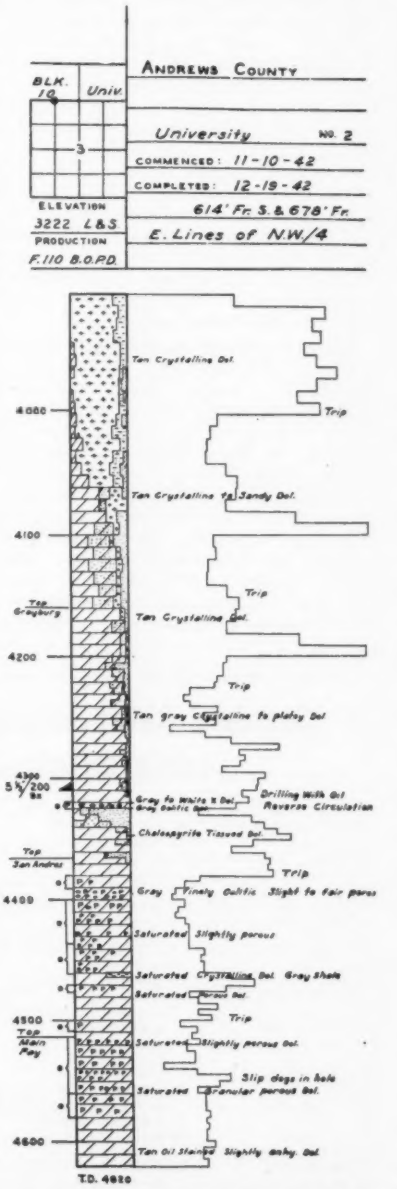


Fig. 2—Sample log. Lithology plotted on percentage basis. Drilling-time data are recorded to right of lithologic column.

parts of the sample examiner's work.

In sandstone, the porosity is determined by the size of the grain, the sorting, and the amount of the cement present. Permeability is largely determined in the same manner as porosity, but here the size of grain and the sorting are most important.

Oil stain and odor are very important and much experience on the part of the sample examiner is required to estimate these accurately. Dry gas will not stain sandstone, but wet gas may show a very light tan stain. Oil is commonly darker, but very high-gravity oil shows no more stain than the gas. Porous sand, containing no stain whatsoever may be suspected of carrying water. In examining samples of oil stain, it is very convenient to have a fluoroscope, which may detect very light stains of high-gravity oil which are not obvious in ordinary light. Best results in detection of oil stains are obtained with mercury vapor lamps emitting light, with wave lengths ranging from 3,300 to 3,800 Angstrom units. Lamps giving light of shorter wave lengths, such as the quartz tube, cause fluorescence of oil, but also cause much mineral fluorescence in the sample, which may confuse the observer.

Limestones and dolomites form important oil reservoirs, and cuttings descriptions furnish one of the chief sources of information concerning them. There are two chief types of porosity in these rocks. The first is intergranular porosity which consists of openings between the crystals, oolites, or other discrete particles of the rock which in its geometry is similar to sandstone porosity. The second is fracture porosity or foramenular porosity which consists of large openings through otherwise solid masses, as fractures and vugs.

The intergranular porosity is easily observed under the binocular microscope where the tiny openings may commonly be seen connected with each other. The larger openings are not ordinarily visible in their entirety under the microscope but are indicated by irregular surfaces lined by crystals which have been formed in a comparatively large cavity. These large openings are much more difficult to detect than the smaller pores and ordinarily they have gone unnoticed unless indicated by the drilling-time or the manner of drilling. Permeability in the fractures or foramenular porosity is almost impossible to determine under the microscope, since there is no means of knowing how far apart the walls of the large openings originally were.

Permeability in intergranular porosity can be estimated qualitatively by noticing the size of the pores and their apparent interconnection. In general, the larger the pores the higher the permeability. The converse, however, is not always true. Some dolomites showing very fine porosity are shown by core analysis to be surprisingly permeable. However, one type of porosity is nonpermeable almost without exception. This is called pin-point porosity and consists of small isolated holes. Some of these holes contain small amounts of asphaltic material and even may contain live oil and gas, but commercial production is not developed from them. So far, no quantitative results about porosity and permeability have been obtained from ordinary cuttings. However, the coarser reverse-circulation cuttings have been analyzed for porosity and permeability with favorable results.

Oil and gas stains are ordinarily readily detectable in limestones and dolomites. The heavy sour oils, as found in the Upper Permian, leave a dark brown stain which is unmistakable. Lighter oils of the Lower Permian rocks show good stains, and the very light oils found in the Lower Paleozoic strata leave an extremely light stain which is difficult to detect under incandescent light, but may be seen in white or ultraviolet light. Since most gases carry a small amount of light oil with them, they will show slight stains in limestones. Gas-oil contacts commonly can be recognized accurately by the darkening of the stain at the top of the oil column. Water may be indicated by lightening of the stain and black asphaltic residues in the samples. Many dolomites have a characteristic sheen on crystal faces within the water zone. However, a well oil-stained section may produce water upon test. This fact may be attributed to later movement of the structure which causes shifting of the water table.

Plotting

After the description of the samples is made, it must be plotted in graphic form to make the information easily available for correlation and study. It is usual to plot this material on a narrow strip of heavy paper or cardboard so that a large number of logs can be laid out to compare and correlate the sections.

It has been found in plotting the lithologic characteristics that strong contrasting colors facilitate correlation and comparison of the sections. While no standard system of symbols has been adopted, the following colors are widely used:

Light blue—Calcareous limestone.

Standard Abbreviations Used in Sample Descriptions

abundant—A or abd.
agglomerate—aggl.
angular—ang.
arenaceous—aren.
argillaceous—argill.
arkosic—ark.
anhydrite—anhyd. or anhy.
bentonite—bent.
biotite—bio.
bituminous—bit. or bitum.
black—blk.
blue—bl.
bottom—bot. or bott.
brown—brn.
calcareous—calc.
carbonaceous—carb.
cement—cmt.
chert—cht. or ch.
clay—cl.
coarse—cse.
common—C
compact—cpt.
composition—comp.
concretion—conc.
crystalline—xln.
dark—dk.
dense—ds. or d/
distributed—dist. or distrib.
dolomite—dol. or dolo.
ferruginous—ferr.
fibrous—fib.
fine—fn.
fissile—fss.
flint—fl.
formation—fm.
frosted—fstd.
Foraminifera—Forams. or F.
fossil(iferous)—foss.
fracture—fract.
glauconite—glauc. or g/
grain—grn.
granite—grt.
granular—grnl.
gray—gy.
green—gn.
gypsum—gyp.
hard—hd.
igneous—ign.
indurated—indur.
laminated—lam.
limestone—ls.
loose—l/
massive—mass.
marl—ml.
material—matl.
medium—med.
micaceous—mic.
mollusc—moll. (M.F.)
mottled—mot.
oölith—oöl.
pyrite—pyr.
rare—R.
regular—reg.
residue—res.
rock—rk.
rounded—rdd.
sand—sd.
sandstone—ss.
sandy—sdy.
scarce—S
shale—sh.
siderite—sid.
slightly—sl/
siliceous—sil. or silic.
some—s/
streak—stk. or strk.
the—t/
thin-bedded—t.b.
tuffaceous—tuff.
variable—var.
very—v/
with—w/
yellow—yl.

Miscellaneous Symbols Used on Well Logs

▲	Chert (fresh)	⌐	Microfossil
◬	Chert (oolitic)	⬭	Concretion
△	Chert (detrital)	▦	Carbonaceous material
×	Fine-crystalline	⧫	Secondary facets
× ×	Medium-crystalline	⌣	Diatoms
× × ×	Coarse-crystalline	∘∘	Ooliths
•	Fine-grained	⊗	Washed residue
••	Medium-grained	M	Mineral concentrate
•••	Coarse-grained	⊙	Screen analysis
□	Pyrite	I	Insoluble residue
⁂	Mica	⏢	Seismometer station
⌐	Macrofossil	⩛	Fracturing

Dark blue—Dolomite.

Red—Red shale.

Gray—Gray shale.

Yellow—Sandstone.

Green—Salt.

Purple—Anhydrite.

Other colors may be added for local necessities.

It has been found very helpful also to plot the drilling time next to the lithologic column on the log strip. In the case of mechanically taken drilling time, a copy of the graph is plotted; with manually taken drilling time, the plotting is done as bar graphs—the common scale being 1 in. equals 100 minutes of drilling time. Porosity and oil stain in the samples are indicated by symbols on either side of the lithologic column.

All tests and showings should be indicated on the margin of the log strip. These should include all drill-stem tests in rotary wells, and amount and kind of fluid in cable-tool holes. It is also helpful to indicate any swabbing tests taken, the acid used, amount of nitroglycerin used and section shot, and perforations in the casing. Casing seats should be indicated on the margin of the log with a notation of the diameter of the casing and the amount of cement used in setting the casing. Total depth, location, and initial production of the well should be shown in the heading of the log strip.

Use of Sample Logs

The first use of these sample logs is stratigraphic correlation by laying the logs alongside each other and matching bed for bed as far as possible. In doing this the geologist must keep in mind probable lateral gradation, probable contamination of samples, and probable changes in intervals from one horizon to another. Care should be taken not to correlate over any greater distance than is necessary. For correlation purposes one tries to select wells close together and extending as far as possible along the lithologic strike.

After these correlations are made and the stratigraphic section established, zones can be found whose tops will make good index beds for structural mapping.

Another important use of sample logs and descriptions is in the analysis and evaluation of any pay zone, especially in limestone reservoirs. This may be done by tabulating the pay sections in columns: First column shows the depth of each sample in the pay section; second column shows the net feet of pay which is the percentage of porosity and saturated material in the sample times the sample interval; and next columns give the quality of the pay which is the geologist's estimate of the porosity and permeability in a qualitative manner, such as slight, fair, medium, and good. Next column shows the probable acre-foot recovery from the pay. This figure is derived from core analyses in this field, if available, or from sample descriptions of pay in fields where the ultimate recovery is reasonably well established from past production. Next column in the analysis is the recovery per acre, which is the acre-foot recovery times the net feet of pay. This gives the recovery per acre for each sample interval. The total of this column gives the recovery per acre for the well.

Of course, this is a volumetric estimate of the recoverable oil from any well, and since limestone reservoirs are commonly heterogeneous in their composition, this recovery estimate falls within wide limits of error.

A somewhat similar method may be used for sandstone reservoirs. However, since sandstone reservoirs are much more uniform in their porosity and permeability, it is commonly possible to assign an acre-foot recovery for an entire field and to obtain the ultimate recovery by multiplication of the net pay—sand thickness in any well by the acre-foot recovery, rendering detailed pay analysis unnecessary.

Logs of cuttings samples are also very useful in studying the characteristics of limestone reservoirs. They give some idea of volume and relative permeability of lenticular pay zones. They are a useful supplement to any coring program undertaken as part of a reservoir study. It is often possible to select gas-oil contacts from cutting logs so as to select points for plug-back or for packer settings in the remedial work.

2. Drillers Logging

THE driller and his assistants assume major responsibility for the successful operation and completion of their assigned well. Frequently these men fail to receive full credit for their role in exploration and exploitation programs. Too often have their opinions and suggestions been neglected or considered unworthy by "technical" personnel.

One of the many duties of the driller during drilling operations is to record and tabulate to the best of his ability the character of the penetrated strata. Frequently his lithologic "calls" are unreliable; many of them, however, are exceptionally accurate, particularly if he is familiar with the drilled section. There are numerous examples where a driller's recordings of formational "tops" are as exact as those determined by the geologist.

Drillers' logs would be greatly improved if geologists would take the time and effort to create a lithologic interest among drillers. Since oil companies are constantly demanding more accuracy in well logging, the driller can be of great assistance in this phase, if he has an understanding of the rock types through which he is drilling. It would not be out of line if these men were given, prior to drilling, an introduction to the various rock varieties to be expected in their wells.

Interpretation of driller's log.—Even though a driller's interpretation of lithology may be incomplete from a geologist's or engineer's viewpoint, his log is generally a result of careful and sincere observation and should under no circumstances be disregarded. Many early drillers' logs are impossible to interpret because of inconsistencies and erroneous lithic recordings; many have been found to aid materially in reevaluation of stratigraphic sections, however, particularly when supplemented by more recently and carefully analyzed stratal data. Interpretation of these logs involves the understanding to routine procedures of the driller and the significance to him of their results.

It is now standard practice in rotary drilling to adhere to constant weight on the bit and rotational speed of the drill pipe. As these operations are now controlled by instruments, the driller has a better opportunity to record the relative hardness of formations by keeping a record of footage drilled per unit of time.

In the event that a geologist is assigned to watch or "sit on" a well, it becomes his responsibility to adjust the driller's lithologic "call" and suggest necessary modification on the tour report before it is submitted to the field or home office. A driller's log in conjunction with other log data is useful in making final interpretative logs.

3. Drilling-Time Logging

RATE of penetration is considered here as the time required to rotary drill a linear unit of depth of a geologic formation of the earth's crust. Drilling-time characteristics constitute a diagnostic property of a rock resulting from its composition, mode of deposition, degree of compaction, and other known physical features by definition of which the

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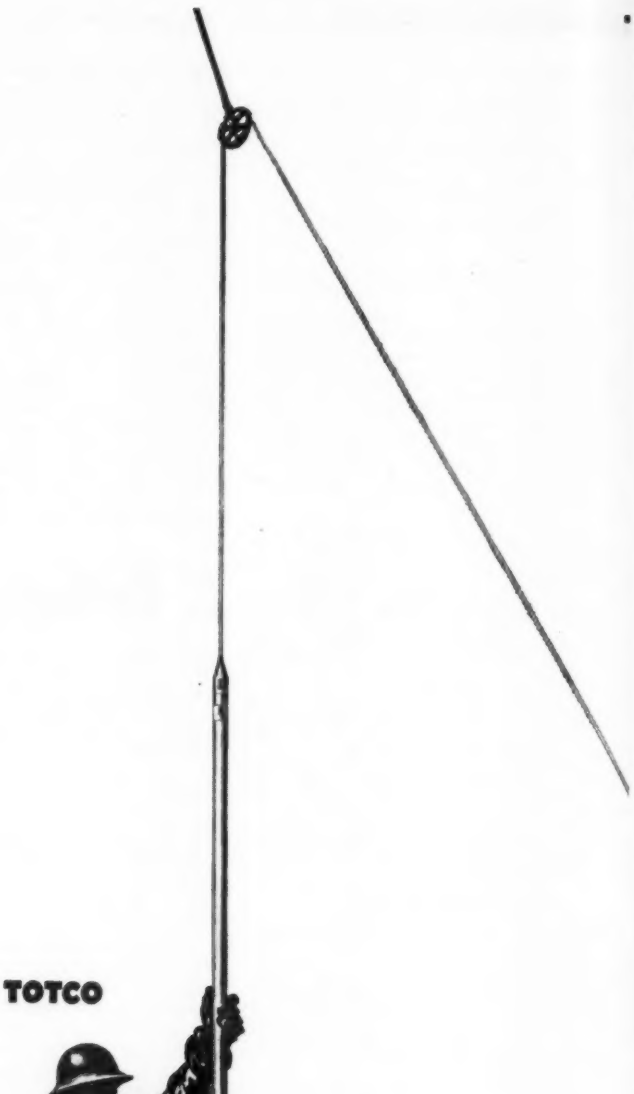

rock is described. At present, drilling-time properties, measurable in terms of rate of penetration, are qualitative in scope and relative in their interpretation.

Definitions.—Rate of penetration is a fixed lithologic property, even though it may be diagnostic only when used as a relative term. Drilling time is the duration of time required in the actual drilling of a unit of depth. Drilling rate is the number of units of depth in a unit of time.

Diagnostic of lithology. — Drillers probably were the first to learn that a change in drilling rate meant a change in the type of rock penetrated by the bit. Limestone, cap rock, shale, or sandstone would be recognized prior to confirmation by examination of the cuttings. Until recently the application of drilling-time data was essentially one of qualitative significance, and methods of observing rate of penetration were formerly far from exact.

Regardless of the method of observation or the crudeness of technique in measuring drilling time, one fact remains unchanged and should be emphasized at the outset. Drilling-time characteristics are but one of many diagnostic properties of a rock; therefore, the use of the rate-of-penetration data must be considered as corroborative of other techniques by which lithologic properties are recognized. Sample examination, coring, electric and radioactivity logging, temperature and caliper surveying, drilling-time logging, and other means of geologic observation must go hand in hand to meet today's demand for more scientific methods for finding oil and gas reserves.

If, when drilling under uniform conditions, the bit's penetration changes from a slow rate to a faster rate or vice versa, it is an indication that a new type of lithology has been encountered. The obvious examples are readily recognizable and well known. A driller could hardly fail to know when he has encountered cap rock or a sandstone by "the way the bit acts." Certainly a change from crystalline limestone to dense dolomite or from hard shale to limestone is more difficult to observe, but any change in the characteristics of lithology should cause a change in the rate of penetration, provided all contributing factors remain constant.

One might question whether rate of penetration is scientifically a property of a rock because, at the present time at least, it is not capable of being cataloged in quantitative terms. This is a weakness in technical procedures, or the fault may be the inability to evaluate contributing factors, but this does not alter the fact that rate of penetration is a petrographic property. If there were no means of determining the identity of mineral constituents of a rock, it would not be wrong to state that mineral composition is a diagnostic property by means of which a specific lithologic type could be identified.

It cannot be claimed that a certain sandstone having 90 per cent quartz, 6 per cent feldspar, 3 per cent femags, and 1 per cent auxiliary minerals, for example, will drill at a rate of 1 ft. in 3 minutes and 15 seconds; nor, conversely, that any rock which drills at that rate is necessarily that particular type of sandstone. Under one set of conditions it may drill in exactly that amount of time, and with other drilling conditions it may require much less or much more time. Nevertheless, we are defining rate of penetration as a fixed lithologic property, comparable to electric, radioactive, or mineralogic properties, and the hypothetical fixed time required to drill 1 ft. of sandstone such as that described above could be defined as diagnostic of that rock.

The qualitative interpretative value of drilling-time data, however, is not impaired by the absence of quantitative calculations. Observations in the drilling of hundreds of thousands of feet of hole have shown that drilling conditions are insignificant in comparison to lithology in determining the rate of penetration of a rock formation. Obvious exceptions have been noted, but the foregoing observation

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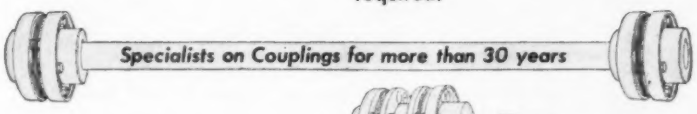

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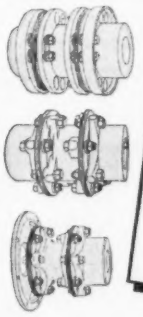

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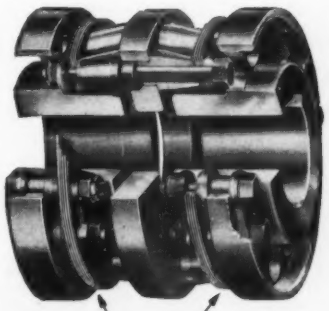

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holds true. It has been shown in many instances that a change in formation will be reflected by a change in drilling time even when very dull bits have been in use or where other conditions would be expected to obliterate any evidences of change in drilling time.

Perhaps the condition that affects drilling time more than any other is holding up on drilling weight as when straightening a hole tending to deviate. Under such disadvantageous conditions, there may be no pronounced change in the actual time required to drill a unit of depth when passing from one lithology into another, but the pattern of the curve plotted from drilling-time data seldom fails to reflect the change in lithology. Adverse drilling conditions do require more careful interpretation than favorable drilling conditions, but the effect of changes in lithology is seldom completely obscured.

Because drilling time is a qualitative property of a rock, it is important that correct identification of lithologies be based on the observation of relative values. A foot of hole that is drilled in 5 minutes at one depth may be interpreted as a sandstone, and another foot drilled under conditions differing from the first-mentioned foot requiring also 5 minutes for drilling may be interpreted as a shale. In each case the interpretation is based on the relative time in comparison to previously drilled feet. The value of the application of drilling-time data to geologic and engineering problems lies in the recognition of this relative interpretation.

Time and rate.—The two means of measuring rate of penetration have been defined; and, as shown, drilling time is a specific value for each foot, and drilling rate is an average value involving the drilling of several feet. The former is more exact and is useful where detailed lithologic information is required and where difficult correlation problems may be solved only in the study of minor features that are best disclosed in the pattern of a log plotted from drilling-time data. The latter method requires less time for recording original data and for plotting and is useful where rapid interpretations are required and where it is used in conjunction with other methods that are based on average data as well, such as sample-examination logs.

Application of Drilling-Time Logs

Many of the uses for drilling-time logs have been cited and illustrated in the literature. The value to drillers, contractors, and operators is well known. The chief concern is the drilling of the greatest amount of hole in the shortest time possible consistent with good safety practices. At the same time anyone connected with the drilling of an oil well knows that the purpose of drilling a hole is to gain information, the use of which may lead to production of oil or gas. The contractor may find drilling-time records most useful in the analysis of operation and the study of down time as well as pay time.

Performance of different types of bits in various formations can be observed directly on drilling-time charts which reflect the types of formations being penetrated. The driller finds drilling-time charts of value as a record of his tour showing exactly how much he drilled, what type of formations were encountered and their depth, and a record of time down for sundry purposes. The guesswork is eliminated. But the driller, like the operator, is concerned with finding oil, and he knows that reservoir beds are porous media overlain by hard or impervious layers. If he knows he is drilling in a section where potentially productive formations may occur and has not been given precise instructions in respect to coring, logging, or testing, the driller uses his best judgment in the interest of the operator. When he observes a drilling-time break, he may stop drilling and circulate samples for examination and wait for orders before drilling past any formation that might carry oil or gas. The drilling-time charts provide an indisputable record of where the top of

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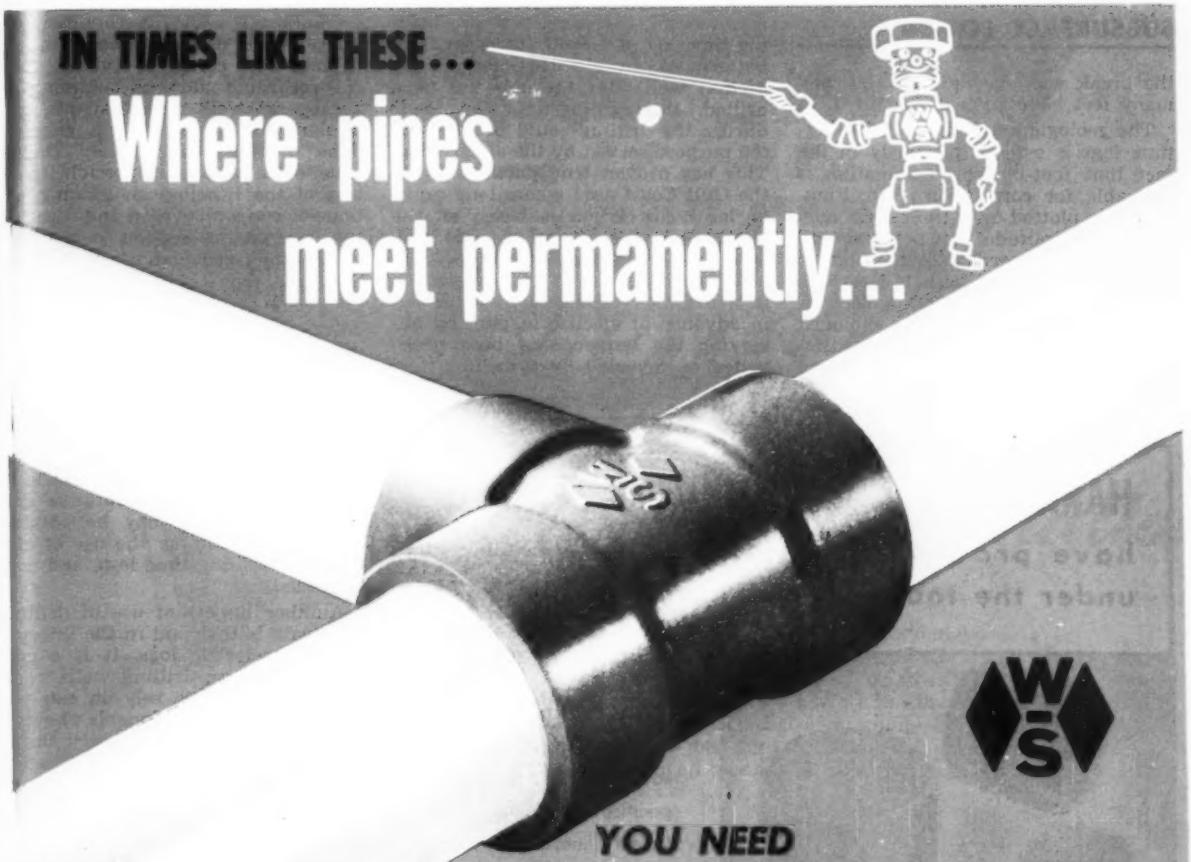

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the break was encountered and how many feet have been drilled in it.

The geologic importance of drilling-time logs is evident primarily in the fact that foot-by-foot information is available for correlation. A drilling-time log, plotted on a time scale such that the amplitude between fast and slow peaks generally correspond to the range between the shale base line and the maximum peak of an electric-potential curve, provides the geologist with data that may be used, within reasonable limits, for much the same purposes as an electric log itself. It is obviously, therefore, that if a drilling-time log of a well corresponds in pattern to an electric-potential log of that well after the hole has been drilled, the drilling-time log made during the drilling could be used for the purpose served by the electric log. This has proved true particularly in the Gulf Coast area where long-range or local correlation is based on the succession of a series of beds predominantly shale and sandstone. The stratigraphic position of any portion of a drilling well can be established in advance of electric logging by observing the sequence of beds penetrated as revealed by a drilling-time log.

The most widely recognized geologic use of drilling time is in connection with coring operations. Careful recording aids in obtaining accuracy in well measurements, particularly where continuous coring is done over a long section. Drilling time often makes it possible to interpret the lithology of missing portions of cores recovered and identifies the portion of section cored from which the recovered core came.

Unless 100 per cent of the core is recovered, it may be difficult to determine the net thickness of productive formations, even with the aid of an electric or radioactivity log. In areas where limestone streaks are interbedded with saturated sandstone, as in the Oligocene formation of South Central Louisiana, it is nearly impossible to interpret an electric log correctly without corroborative data. Greatest accuracy may be obtained in such problems by the use of electric logs, drilling-time logs, and cores combined.

Another important use of drilling-time data is their aid in the interpretation of electric logs. It is a common practice in drilling wells in the Gulf Coast area to rely on side-wall cores to check questionable shows of saturation in beds not cored during the drilling. Some of these questionable shows are thin calcareous beds which produce resistivity kicks on electric logs that are not unlike those that might be caused by saturated sandstones. The detailed examination of an electric log in conjunction with an accurate drilling-time log may reveal information on these questionable beds sufficient to identify them as calcareous or arenaceous. This use of drilling-time logs reduces the cost of side-wall coring and effects a further saving of rig time.

The use of drilling-time logs as an aid in the interpretation of electric logs may be applied in the problem of reserves estimate. Estimates of ultimate reserves of oil and gas often fail to represent the actual amount of eventual recovery. Although great progress has been made in understanding physical and chemical reservoir conditions and factors relating to the recovery of petroleum resources, the amount of reserves in place is given only as an estimate. Some even discount the value of making estimates of this character because of the lack of knowledge or possession of empirical data necessary to arrive at reliable conclusions. Efforts are continuously being made to increase the accuracy of reserves estimates. The oil or gas content of a reservoir bed is generally given in barrels of oil or thousand cubic feet of gas per acre-foot. Lack of adequate knowledge pertaining to the reservoir conditions limits the accuracy of the estimate of the formation's content per unit volume, but the factor given is the best available in light of present-day scientific understanding. An

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estimate of the areal extent of a reservoir bed is also subject to considerable latitude because of the lack of knowledge concerning migration channels and underground drainage conditions. The estimate again is made on the best information that can be supplied by the subsurface geologist, after mapping the structure in which the producing horizon is found.

In establishing the net effective thickness of the reservoir bed, there is a greater means of eliminating the necessity of an estimate, provided adequate data are available. In a section where reservoir beds are very uniform in respect to lithology, porosity, and permeability, the thickness may be determined by the driller's record, an electric log, a radioactivity log, or other reliable methods of logging or observing a formation. In those reservoir beds where the lithology is not uniform all available means may be required to determine the net effective thickness of that bed. Core information and analyses, electric and radioactivity logs, and drilling-time logs contribute to the best possible answer.

Shale Breaks

There are many cases where thin shale breaks in a sandstone reservoir or tight calcareous streaks interbedded with saturated sandstone are not indicated on electric or radioactivity logs. If recorded on a short enough depth interval, however, drilling time will seldom fail to disclose the presence and thickness of such breaks. The writer has used drilling time recorded at intervals of one-tenth of a foot in a productive section where many and very thin impervious streaks were present and only by this means was able to determine the exact net effective thickness of the reservoir. Therefore, if positive information can be gained as to the thickness of a formation, one of the three essential data making up a reserves estimate can be assigned a fixed value, and the accuracy of the final answer is increased.

Perhaps the greatest argument for the use of drilling-time logs is their value as insurance against the loss of geologic information in the event that other types of logging are precluded because of well conditions or in case of a junked hole. Because a drilling-time log provides essential data corresponding to an electric-potential log, it can be used for correlation to determine the stratigraphic and structural position of a well which might otherwise remain unknown. It may also reveal the presence of probably porous beds that may be saturated because of their structural position, and therefore the economic risk of drilling a new hole or abandoning a location may be substantially reduced.

4. Drilling-Mud and Cuttings Analyses

TODAY the determination of the fluid content of the porous formations penetrated by the bit so that no oil or gas-bearing formations will be overlooked constitutes one of the most important problems in drilling for oil and gas. Modern mud analysis, well-logging equipment, and improved technique allow for the detection of the most minute quantities of oil and gas and the exact placing of these shows at the proper depth.

Well-logging service has been developed using the following facts as a basis: In drilling a well the bit disintegrates a cylindrical section of the formation. If the pore spaces of this cylinder contain oil or gas, part of these fluids will be entrained by the drilling mud and part will be retained on or in the cuttings. If the drilling fluid and the cuttings are continuously tested on their return to the surface and the results of these tests correlated with the depth of origin, the presence or absence of oil or gas in specific formations can be determined.

In the application of the method continuous tests are made on the

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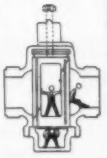

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mud and cuttings returning to the surface. The test for gas in the mud is made by diverting a portion of the circulating mud from the flow line to a separator or gas trap, where the mud is removed. A stream of air is drawn countercurrent to the flow of mud in the gas trap, thus materially assisting the separation of the gas from the mud. The air-gas mixture is then drawn into a "hot wire" gas-detector instrument, where the percentage of combustible gas is determined. The amount of methane gas present in the total is determined by controlling the temperature of the filament in the gas detector.

Thus, the gas readings in the mud are recorded as total gas, which includes all the combustible gases and methane gas. This "breakdown" of gas readings is made because recent studies have indicated that, with few exceptions, all productive horizons logged by the mud-analysis method have shown a definite increase of methane gas. Therefore, inclusion of the methane curve on the new log is important to operators, since, normally, those zones that do not show that an increase of methane may be condemned.

The test for gas in the cuttings is made by placing a small sample of the cuttings with a measured amount of water in a closed-container-type, high-speed grinder. After cuttings are ground, the air-gas mixture in the container is examined for gas in the same manner as described in the preceding paragraph. Here, too, the gas is reported as total gas and methane gas.

The presence of oil in the drilling fluid is detected by a physical examination of the drilling mud under ultraviolet light. A sample of the mud is treated to reduce the surface tension and gel strength, after which it is placed in a viewing box. This box is so constructed that all external light is excluded; thus the sample may be subjected selectively to either ultraviolet or white light. The magnitude of the oil shows in fluid-logging units is based on the amounts of observed fluorescence of the crude oil.

Determining Oil

Oil in the cuttings is determined by using the same ultraviolet-light arrangement. Freshly washed cuttings are placed under the light and observed for fluorescence. The cuttings are then treated with various leaching agents to see if they will give a "cut." Certain minerals fluoresce when subjected to ultraviolet light. This fluorescence can be distinguished from crude-oil fluorescence by the fact that mineral fluorescence will not give a cut when treated with a leaching agent.

Further, the cuttings are subjected to a detailed examination under the microscope, in which the operator records the estimated percentage of limestone, sandstone, shale, and anhydrite. Note is also made of indications of porosity and permeability.

A depth meter, pump-stroke counter, and pump-rate meter provide the necessary data for obtaining a rate-of-penetration curve and for properly correlating with depth any shows of oil and gas found in the mud and cutting samples at the surface. The log is prepared as a plot of the magnitude of the oil and gas shows versus depth. Also given is a sand or lime-index curve showing the relative amounts of either sand or lime in the cuttings. This curve is intended to be used as a supplement to the drilling-rate curve. The drilling-rate curve and the sand-index curve are used as indications of porosity and permeability values and of changing formation. They are also used for correlation between wells in the same general area because of characteristic variations in formation hardnesses and sand or lime content.

The well-logging service is used as wells are being drilled, and results on any formation are available as

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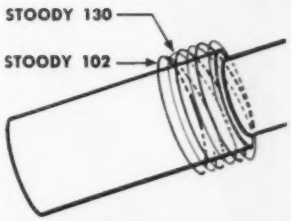
Here's an improved technique for hard-facing worn tool joints with the automatic electric welding head. It has been successfully used in the mid-continent area for over two years. Instead of one alloy alone, two different Stoody hard-metals are applied to the joint. Commencing near the shoulder, a bead of Stoody 102 is welded in a spiral until approximately 3" of joint is covered. The pitch is spaced the width of one bead.

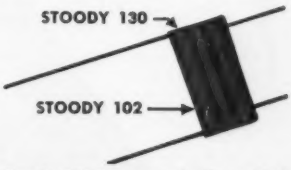
Stoody 130, the counterpart of Tube Borium for automatic application, is then welded in the remaining spaces between the original beads. The long-wearing tungsten carbide deposits of Stoody 130 are amply supported on each side with wear-resistant Stoody 102. By alternating the two alloys, excellent life increase is secured and undercutting of the hard-metal as well as washboard wear-effects are virtually eliminated.

In most principal oil fields today, automatic tool joint hard-facing with Stoody Alloys is available from operators having truck-mounted equipment. The work is done at the well site, saving time and expense. Names of operators are available upon request.

For companies preferring manual hard-facing of tool joints, both Acetylene Tube Borium and Electric Tube Borium are still available, with excellent performance records.



Apply Stoody 102 around edge of tool joint shoulder, then feed along joint in a spiral.



Stoody 130 is automatically welded between beads of 102. Entire hard-faced area should cover approximately 3" of joint.

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soon as the mud used in drilling the formation reaches the surface. The system does not interfere with the drilling operations in any way, and no changes in ordinary drilling equipment or procedure are required to make it workable. The logging units are in reality mobile field laboratories. In addition to the logging instruments, each unit is equipped with complete mud-testing equipment. Tests for mud weight, viscosity, water loss, cake thickness, salinity, and other characteristics can be made so that a satisfactory drilling mud may be maintained.

The principal application has been in the drilling of wildcat or exploratory wells, where its usefulness is apparent in many phases of the well program. Coring can be reduced to a minimum by using mud-analysis logging to choose only those sections to core which contain oil or gas.

Sidewall Samples Taken

In certain sections of the country some exploratory wells are drilled without taking any cores. After the electrical log is run, sidewall samples are taken to check the possible indications shown on the electric log. In this manner, the wells are drilled with a minimum output of time and expense, but ever present is the possibility that a productive sand or lim will be missed. This possibility is removed by using well logging service during drilling. This type of logging can be depended upon to pick up indications of all possibly productive formations, and the fluid content of such formations can be further checked by sidewall cores.

This exploratory method is particularly useful in areas of abnormally high pressure, where slough shale is encountered, and, in general, where coring is difficult or impossible. In cases on record, hole trouble developed so seriously that it was impossible to make other surveys, and the mud and cuttings-analysis log was the principal, if not the only, source of information on the lower section of the hole.

The method does not present a complete subsurface picture. It does not give quantitative determinations of the amount of oil and gas occurring in the formation, nor does it furnish quantitative information on the productivity of the oil and gas horizons. However, the method does give reliable qualitative information on the occurrence of oil and gas, and the interpretation of the log should be made in the light of all available information on that section of the hole logged. It is extremely valuable in minimizing coring, as outlined before, in removing the ever-present possibility that a production zone will be missed and in rounding out the picture presented by other formation data.

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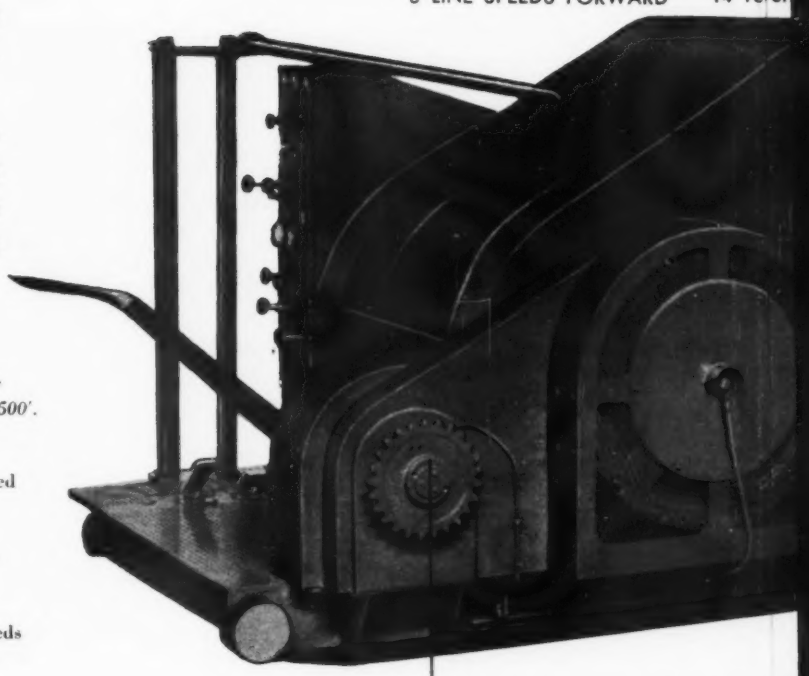

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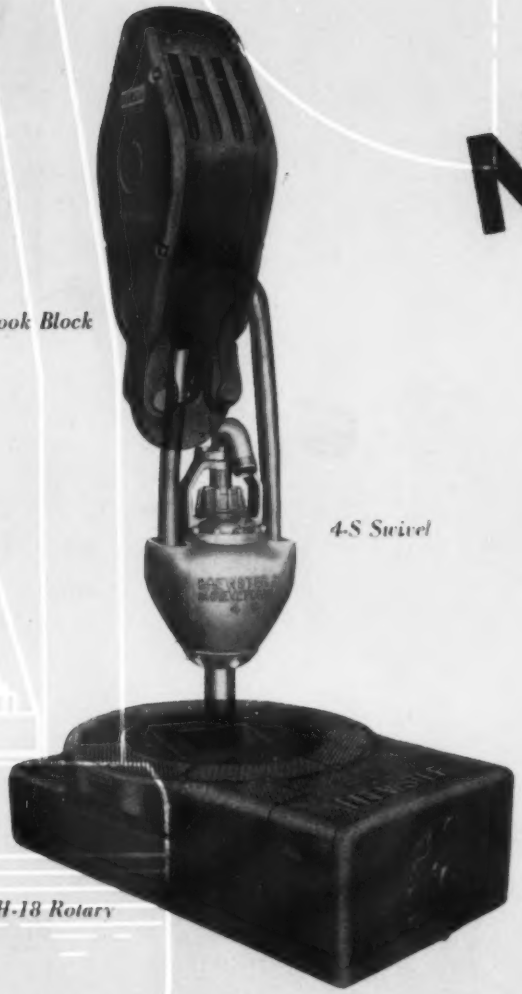

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5. Composite Cuttings-Analysis Logging

INFORMATION obtained simultaneous with the drilling of a wildcat well is of extreme importance, and this knowledge can be acquired at no other time. The establishment of a 24-hour-a-day logging service is based on this premise.

In order to log a well adequately, the cuttings must be examined and tested for oil and gas concurrent with the drilling, owing to the rapid dissipation of the lighter hydrocarbons that may be brought to the surface in the cuttings. Recommendations concerning coring or drill-stem testing may be quickly and accurately made at a time when it is most important. Conversely, much rig time can be saved by eliminating many unnecessary cores and tests.

It has been proved that cuttings from a well brought to the surface by the mud stream will retain a small fraction of oil or gas, if an oil or gas-bearing stratum has been penetrated. However, this oil or gas may be present in the cuttings in such minute quantities that it cannot be visually or nasally detected. Mechanical and electrical instruments have been developed to detect and relatively measure obscure oil and gas showings in the samples that might otherwise be overlooked.

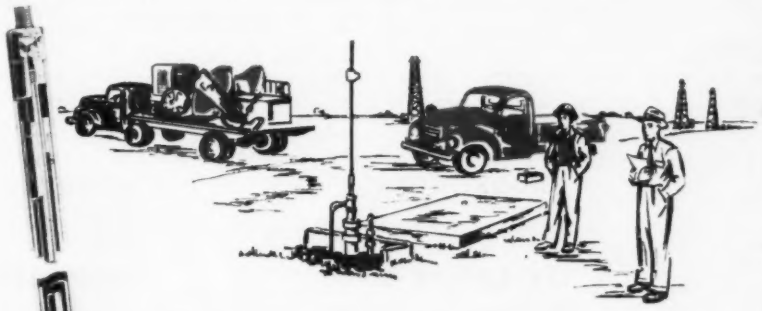
This continuous logging process is carried on in a trailer laboratory, which is located at the well as near to the mud-discharge line as possible. A portion of the mud from the flow line is diverted into the laboratory, where it goes through a miniature shale shaker, which separates the cuttings from the mud, allowing the mud to return to the pits and providing a continuous flow of samples available for examination. The availability of the cuttings within the laboratory in a steady flow permits examination more frequently and without contamination by previously drilled sediments.

A cable is run from the laboratory over a sheave near the top of the derrick and down to the swivel. Thus, as the kelly is lowered, the drilling-time mechanism in the laboratory in turn operates and records the time for each foot of hole drilled. The importance of accurate drilling time has been proved, and this chart is closely watched during the process of drilling for any drilling breaks that might occur. A drilling break usually indicates a porous zone which is a potential oil or gas reservoir. When a drilling break is encountered, drilling is suspended, the cuttings are circulated up from that zone, and a determination is made of any oil or gas content. The suspension of drilling near the top of any oil or gas zone is of great importance in the event of a relatively thin pay section. A reliable drill-stem test cannot be made if the bit has penetrated the water zone, if one is present, beneath the oil or gas.

Routine tests are made each 2 ft. of hole drilled from cuttings collected at a predetermined interval. The length of time necessary for cuttings to reach the surface from the bottom of the hole varies with the depth and condition of the hole as well as the capacity of the pump. This amount of sample lag is determined frequently to allow sampling for the correct depth.

The following method is a reliable means of determining the lag:

Some material that can be easily detected, preferably about the size and density of the actual cuttings, is placed in the drill pipe when a connection is being made. The length of time required for the pump to replace the fluid in the drill pipe is calculated, and this time subtracted from the round-trip time will give the sample-lag time at the particular depth. Two clocks are mounted in a panel, one clock showing the correct time, and the other set



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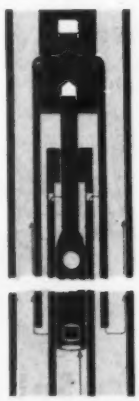

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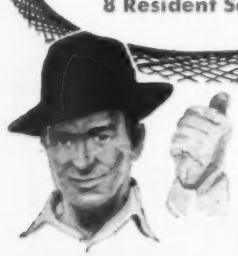

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back to allow for the sample lag. When the hands on the second clock show the time that a certain depth was drilled, cuttings are collected for that interval. Thus all tests and examinations are made from the true depth.

The cuttings for each 2 ft. are washed and decanted several times until they are clean. A measured amount of cuttings is put into a container, which is filled half full with fresh water. The container is constructed with blades in the bottom, which revolve at a very high speed, pulverizing the cuttings. This has the effect of exposing the pore spaces within each chip. Any gas that might be contained in the pores or might adhere to the sample is released by the agitation and brought to the surface of the water.

By applying a vacuum to the container, the air-gas mixture is drawn over a hot platinum filament of a balanced electrical circuit. If any combustible gases are present in the mixture, they will increase the temperature of the platinum filament and consequently throw the system out of balance. This differential is recorded on a galvanometer.

Methane and ethane ignite at a temperature considerably higher than propane, butane, etc., and shale gas. Thus it is possible to distinguish readily between the higher and lower-burning-point gases. The temperature of the platinum filament is adjusted to ignite all hydrocarbon gases present and is then lowered to a point at which the methane and ethane will not ignite. The difference between the two readings will thus be the reading of the methane and ethane present. As this is a qualitative test only, results must be correlated with the lithologic characteristics of the section, for porosity and permeability control the magnitude of the readings obtained.

Petroleum oils show a fluorescence under an ultraviolet light. The maximum fluorescence occurs with a lamp having a wave length of between 3,200 and 3,800 angstroms. A 230-volt mercury-vapor lamp with suitable filters is considered most effective for detecting residual oil in the cuttings. The lamp is enclosed in a light-tight box with a viewer that has a magnification of approximately three and one-half times. Samples are examined under the fluoroscope every 2 ft. for any oil content. As many minerals will give off fluorescence of various colors, it is necessary to distinguish between mineral and oil fluorescence. This is done by putting a portion of the fluorescent material into a color-reaction plate and applying a petroleum solvent to it. If oil is present, a "cut" will be obtained; that is, some of the oil will be dissolved out and will come to the surface of the cutting agent, causing the fluid to "bloom" or fuoresce. If no cut is obtained, it can be assumed that the fluorescent is from a mineral source. Examination under the microscope will probably verify the presence of the mineral.

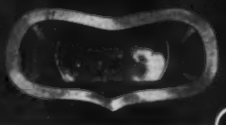
Refined rig greases and oils that may contaminate the cuttings may easily be detected by experimentation. The color of the fluorescence obtained from crude petroleum may range from brown to yellow and through various tints of green and blue to near white, dependent upon the gravity or impurities. The color may be important in distinguishing separate zones in the same well where cavings from above may be present, as well as in correlating the same zone from well to well.

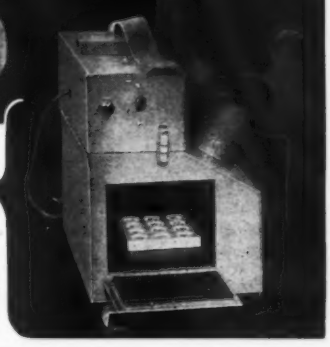
A microscopic examination of all cuttings is made by the geologist assigned to the laboratory as the well progresses. A detailed interpretative lithologic log is made from this examination. An attempt is made before and during the logging of a well in an unfamiliar area to obtain as much available geologic knowledge as possible. These studies, together with the interpretative geologic log, make it possible to pick important formations tops. The geologist is present when all cores are removed, and these can, if desired, be sealed preparatory to core analysis.

Equipment is maintained for the testing of drilling-mud characteristics; tests are made as often as it is desired for weight, water loss, viscosity, filter cake, salinity, or any other properties to insure a satisfactory drilling mud.

The results of all tests and examinations, as well as the drilling-time record, are plotted graphically on a log having a scale of 5 in. to 100 ft. to permit the showing of as much detail as possible. The first column on the final composite log denotes the characteristics of the mud at the depth each check was made, as well as

the "Tool" that gives BIT-END INFORMATION at the surface





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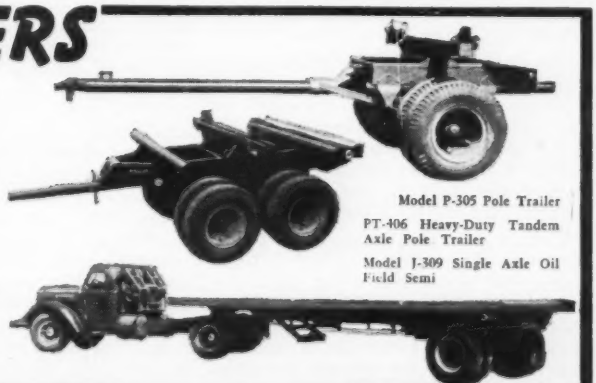

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Model J-309 Single Axle Oil Field Semi

symbols indicating new bits and circulating and coring points. The drilling-time curve in the next three columns is plotted in minutes per foot, and the horizontal scale is amplified to show minor variations in the drilling rate. The center two columns of the log show the depth and graphic lithologic log. To the right are shown the results of oil and gas tests. Since these tests are purely qualitative, an arbitrary scale of 100 per cent has been established to show comparative readings.

Oil is shown as a solid line; the "high" gas reading is plotted with a dotted line, and the "low" gas reading with a dashed line. The oil and methane shows are colored green and red, respectively, on the final log for quick noting. The last column of the log is devoted to a detailed description of the lithology. Formation tops and results of coring and drill-stem tests, as well as any other pertinent data, are suitably located on the log. A modified daily log covering the previous 24-hour period is sent each day to operators upon request.

The cutting-analysis-logging method is a direct means of determining the presence of oil or gas-bearing formations. Oil and gas in the cuttings can be detected by the instruments maintained in quantities too minute to be observed in any other way. Accurate determinations can be made of odorless gases as well as high-gravity oil or distillate. These may be too elusive to detect with a microscope and the human senses. With a geologist or technician on duty 24 hours a day, an accurate valuation of the section may be made consistent with the drilling. Experience has shown that not all productive zones are drilled at a faster rate even though porosity is present, an example being the Simpson sand of southern Kansas and Oklahoma. However, since cuttings are analyzed each 2 ft. regardless of the rate of penetration, a zone of this type would be detected from any oil or gas showing.As the cuttings from the well are used for all tests, any mud that might carry combustible gas due either to chemical action or recirculation does not affect the results.

The development of mechanical and electric well-logging instruments has greatly eliminated the chance of human error or misjudgment. It is of no less importance, however, that qualified personnel correlate and interpret the data in order that the greatest benefit be obtained.

Statistics show new oil fields progressively becoming harder to find. Many new areas are being explored and new zones in old areas being tested. It is becoming necessary to employ the best available manpower and methods in the search for new petroleum reserves. After a location has been made, it is of the utmost importance that the well be accurately evaluated for oil or gas, or the preliminary work will have been done in vain. The cuttings-analysis-logging method should leave the operator without question regarding the section logged.

6. Electric Logging

THE electric log consists of a spontaneous-potential curve and, generally, three resistivity curves. The specific recording practice and the type and number of curves vary from one geologic province to another, depending upon the nature of the formations and the problems to be solved.

Spontaneous Potential

The spontaneous-potential (S.P.) log is used to distinguish between permeable and nonpermeable formations, as, for example, sand and shale of permeable and nonpermeable limestone. However, a quantitative relationship between porosity or permeability and spontaneous potential does not exist. Empirical relationships have been found, however, and have been established in specific pools for particular formations.

The spontaneous-potential log of a bore hole is a record of the potentials measured in the mud along the hole. In fact, the potentials are measured between an electrode lowered into the hole and another electrode at the surface and are related to an arbitrary constant. As the S.P. log is generally flat in front of shales and shows positive or negative anomalies opposite permeable beds, it is convenient to take the line obtained in front of shales as the base line.

Spontaneous-potential anomalies in a bore hole are due primarily to the electromotive forces generated by two different electrical phenomena. The first of these and the more important is the electrochemical cell formed between the drilling fluid, the fluid in the permeable zone, and the shale surrounding the permeable section.

The second of these electromotive forces may result from the filtration of the drilling fluid into a permeable zone. The principle is a recognized phenomenon of electrochemistry (streaming potential).

There may be other factors effective in generating bore-hole potentials, but, at present, the phenomena just mentioned appear to be those of major importance.

Whatever their origin may be (electrochemical or electrokinetic), the electromotive forces give rise to a current, which flows through the permeable layers, then spreads into the adjacent impervious formations, and returns through the mud filling the hole. The S.P. anomalies correspond to the drop of potential created by the circulation of the current in the hole, and thus measure only a part of the total electromotive forces. Consequently, the characteristics of the S.P. log, and particularly the amplitude of the anomalies, are a function of several factors, such as the salinity of the mud and the formation fluid, the resistivity of the surrounding formations, bed thickness, hole diameter, amount of shaly material in the permeable bed, and depth of mud invasion.

Fresh - water - bearing formations.—The S.P. developed by a fresh-water-bearing formation is usually very

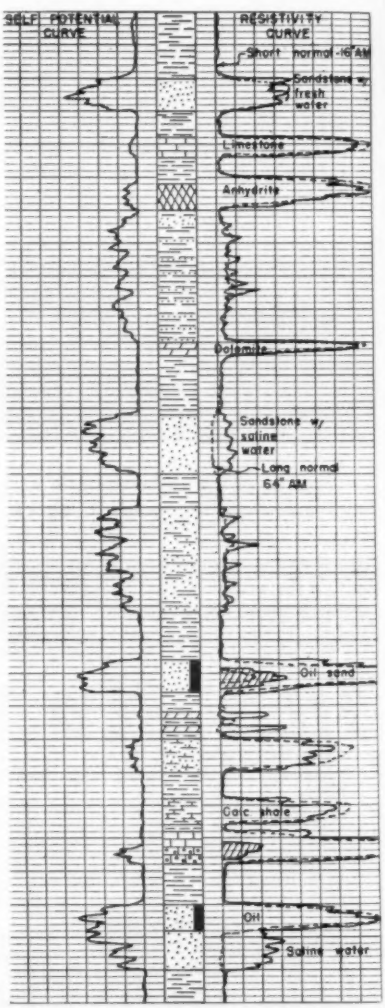
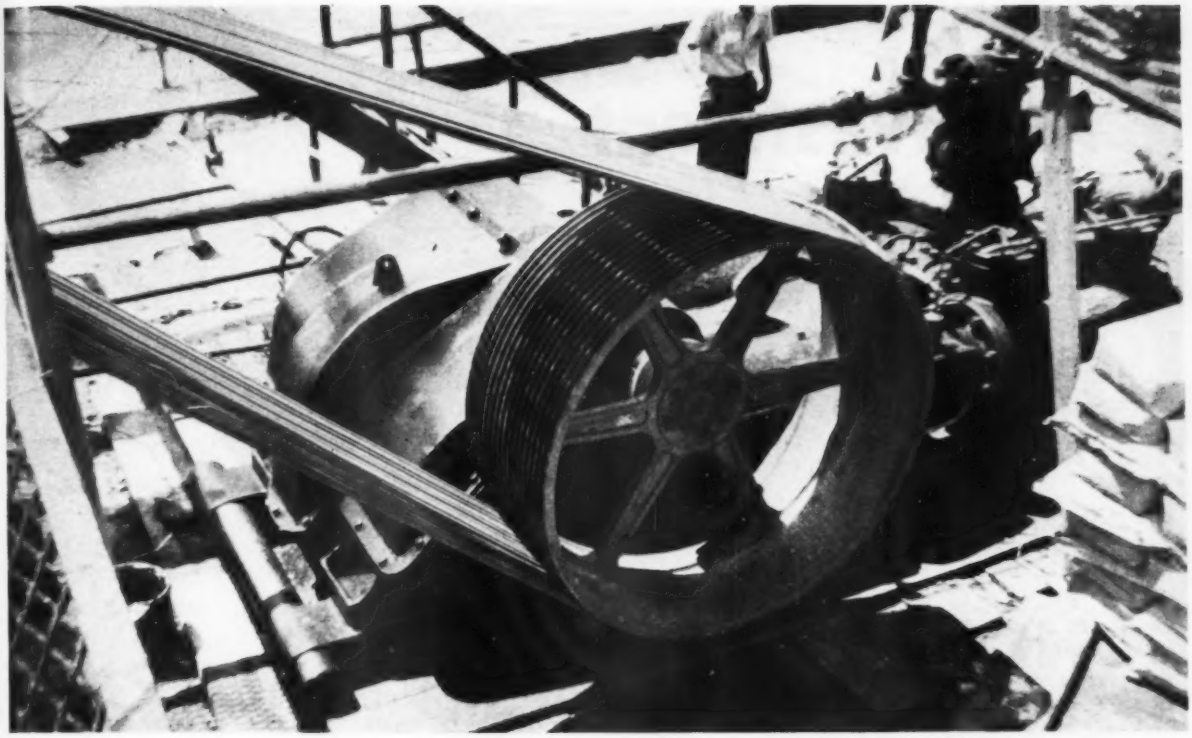


Fig. 1—Schematic electrical log showing relationship between electrical characteristics and various lithologic types.



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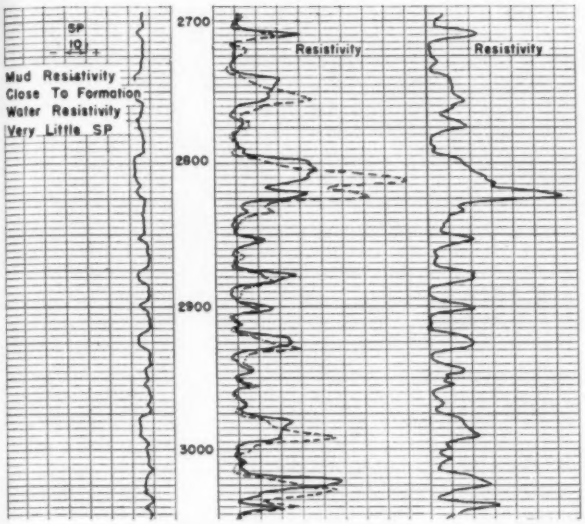

Fig. 2—Small S.P. indicates that resistivities of mud and water are close.

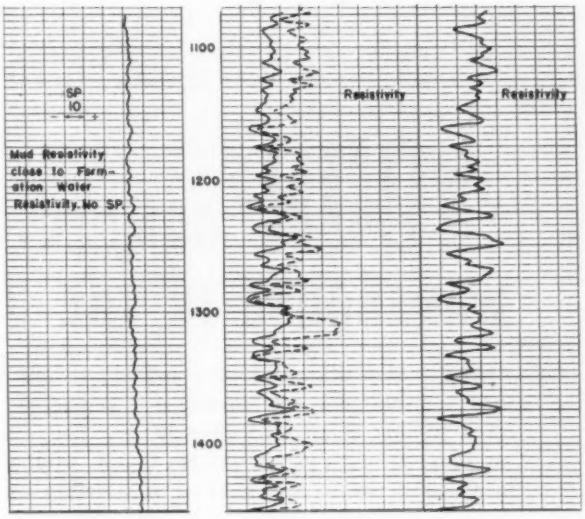

Fig. 3—Mud resistivity very close to formation-water resistivity as indicated by essentially no S.P.

small (Fig. 2), frequently nonexistent (Fig. 3), and sometimes reversed (Fig. 4), as compared with the S.P. across a salt-water-bearing formation. As most drilling fluids are comparatively fresh and as the electrochemical effect has been recognized as being generally preponderant, it can be shown mathematically that, when the resistivity of the drilling fluid is appreciably higher than that of the formation water, the S.P. is high and negative; when the two are the same, the S.P. is zero; and when the drilling-fluid resistivity is lower than the formation-water resistivity, the S.P. is positive. Therefore, in the case of fresh-water sands and a fresh mud, S.P.'s usually are small.

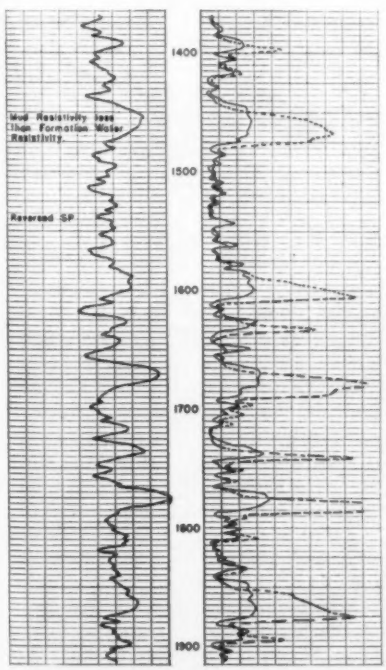

Fig. 4—Reversed S.P. indicates mud resistivity is less than formation-water resistivity.

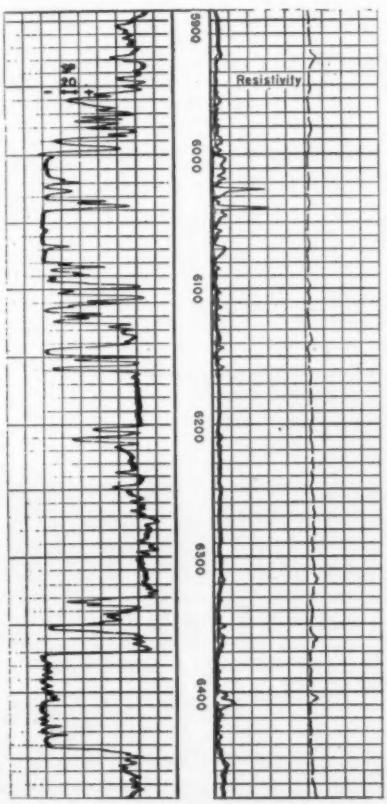

Fig. 5—Mud resistivity is greater than formation-water resistivity resulting in negative S.P.

Salt-water-bearing formations.—The S.P. developed by a salt-water-bearing formation is generally sharp, has an appreciable magnitude up to 100 or 200 mv., and is negative with respect to the surrounding shale or nonpermeable formations (Fig. 5). Such a behavior is entirely in agreement with results to be expected from a consideration of the formulas as described above when the drilling fluid has a higher resistivity (lower salinity) than the formation water. The presence of oil in the shaly sand will often lower the S.P. (Fig. 6).

Effect of porosity and permeability. As noted beforehand, there is no quantitative relationship between S.P. and porosity or permeability. However, in a particular section, marked variations in the magnitude of the spontaneous potential generally are associated with changes in the physical properties of the formation, although such changes can be identified only in the qualitative manner. For example, in a sand with only 50 mv., S.P. in a section where the sands average, say, 100 mv., the lower S.P. may be the resultant of a bed-thickness effect, of shaliness, or of an increased resistivity. Shaliness probably would mean less permeability, whereas increased resistivity probably would indicate less porosity or less water saturation.

Effect of drilling mud.—It has been seen that the S.P. is directly affected by the resistivity and, therefore, by the salinity of the drilling fluid. Considering a salt-water-bearing formation, the S.P. will decrease with decreasing resistivity or increasing salinity of the drilling mud. Not only is there a decrease in the magnitude of the S.P., but the anomalies lose definition and the log becomes featureless. Fig. 7 is a typical compari-

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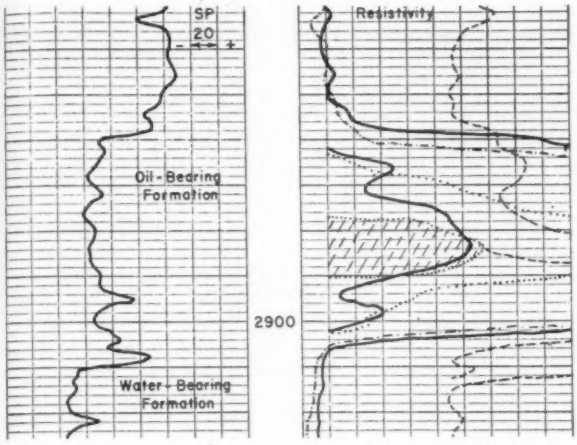

Fig. 6—Log showing less S.P. across an oil-bearing formation as compared to S.P. of a salt-water-bearing formation.

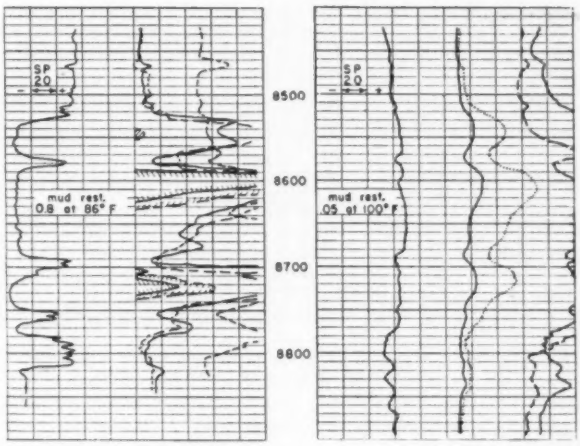

Fig. 7—These two logs are from the same well. The left one was run with normal mud and the other with low resistive (salty) mud.

son of two logs in the same well, one with a low-resistivity (salty) mud, the other with a normal mud.

Mud-resistivity measurements are given on the log headings as well as the temperatures at which the measurements were made. Since drilling-fluid resistivities vary inversely with temperature and since well-bore temperatures usually are different from surface temperatures, corrections have to be made for mud resistivities measured at the surface in order to evaluate their effect in the hole. For example, a mud with a resistivity of 2.0 ohms at 64° F. will have a resistivity of only 0.70 ohms at 200° F.

Factors influencing resistivity of drilling fluids.—The factors that influence the resistivity of drilling fluids are the following:

1. Temperature. Resistivity decreases with increasing temperature.

2. Sodium chloride salinity. Resistivity decreases with increasing sodium chloride salinity.

3. Barite and limestone. Resistivity tends to increase slightly with the addition of these common weighting materials.

4. Cement and sodium bicarbonate. The addition of either or both of these materials tends to reduce resistivity.

5. Sodium pyrophosphate. Resistivity decreases but not uniformly as it does with increasing temperature or sodium chloride salinity.

6. Quebracho. The effect on resistivity of quantities generally used is negligible.

7. Starch (i.e., "Impermex"). The resistivity is unaffected except as the preservatives may change the resistivity.

8. Caustic soda. The resistivity is decreased with the addition of caustic soda.

Effect of bed thickness.—Research has indicated that, all other factors remaining the same, when the bed is less than four times the hole diameter in thickness, the S.P. will decrease with decreasing bed thickness.

A section composed of interbedded thin shales and permeable sands may have much less S.P. than the sand would have if the thin shale beds were not present. This is an important factor in evaluating thin sand zones and explains the good production obtained sometimes from sandy zones with low S.P.

Effect of special muds.—The normal constituents of drilling muds, natural clay, aquagel, baroid, starch, and other additives have no effect on the S.P. log except as they change the resistivity of the mud. On the other hand, two muds used occasionally, silicate and oil-base, affect the S.P. in a manner unrelated to resistivity.

A positive S.P. generally is recorded in a silicate mud opposite a permeable sand, although the mud resistivity is higher than the resistivity of the formation water (Fig. 8). The anomalies are small but sharp and

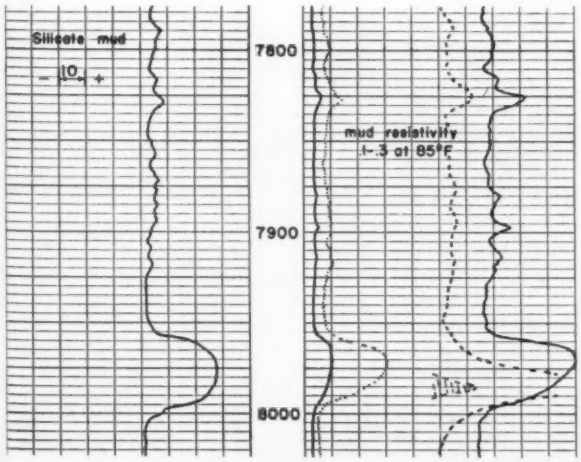

Fig. 8—Log made in sodium-silicate mud showing reversal of S.P. curve.

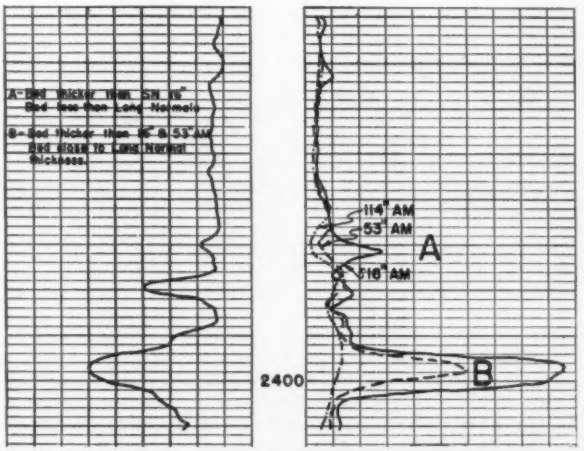
A- Bed thicker than SN is Bed less than Long Normal
B- Bed thicker than 16" & 53" AM Bed close to Long Normal thickness.
114" AM
53" AM
A
16" AM
2400
B

Fig. 9—Log illustrating the effects of resistive beds of various thicknesses on normal curves.

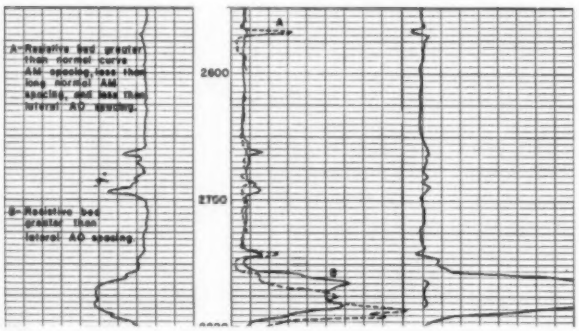
A- Resistive bed greater than normal curve AM spacing, less than long normal AM spacing, and less than lateral AO spacing.
B- Resistive bed greater than lateral AO spacing.
2600
2700

Fig. 10—Log illustrating behavior of lateral curve with resistive beds of different thicknesses.

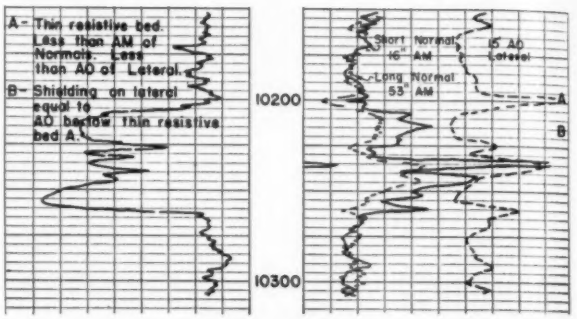
A- Thin resistive bed. Less than AM of Normals. Less than AO of Lateral.
B- Shielding on lateral equal to AO below thin resistive bed A.
10200
10300
Short Normal 16" AM
Long Normal 53" AM
15 AO Lateral

Fig. 11—The shielding effect of thin resistive beds on the lateral curve is illustrated by this log.

are easily seen when the proper S.P. scale is used.

S.P. logs in true oil-base muds, those with a water content of less than 5 per cent and a resistivity of several thousand ohms, usually are not satisfactory for distinguishing between permeable and nonpermeable formations or for locating formation boundaries. On the other hand, normal S.P. logs are obtained in oil-emulsion muds. Such muds are a mixture of water-base and oil-base mud, and the resistivity generally has a value of from 2 to 10 ohms m.²/m.

Effect of variation in hydrostatic pressure.—It has been demonstrated many times that a change in the hydrostatic pressure exerted by the mud column on a permeable formation will change the magnitude of the S.P. An increased pressure increases the S.P. while a lowered pressure lowers the S.P. Since the change generally occurs opposite only the permeable zones, these can sometimes be located and qualitatively compared by measuring the S.P. at different hydrostatic pressures. Such a log is called an "S.P.D.," spontaneous-potential-differential, log.

Resistivity

Rock formations, except for example, massive sulfide ore bodies and graphitic beds, are capable of transmitting an electric current only by means of the absorbed water which they contain. They would be nonconductive if they were entirely dry. The absorbed water containing dissolved salts constitutes an electrolyte able to conduct the current. The more electrolyte contained in a formation and the richer this electrolyte in dissolved salts, the greater the conductivity and therefore the less the resistivity of the formation. Fresh water, for example, has only a small amount of dissolved salts and is, therefore, a poor conductor of an electric current; salt water with a large amount of dissolved salt is a good conductor.

Electric-logging practice is to measure, not the conductivity, but its reciprocal, the electrical resistivity. This is the resistance of a volume of rock having a unit of length and a unit of cross-section. The resistivity of rocks is expressed in ohms per meter squared per meter (ohms m.²/m.) or ohmmeters. This has been found to be a convenient unit for practical purposes, giving values between a fraction of an ohm and several thousand ohms.

The resistivity measured in a drill hole and recorded on the electric log is called "apparent resistivity." This will vary from the "true formation resistivity" as a function of bed thickness, electrode spacing, diameter of the bore hole, resistivity of the drilling mud, and, in the case of permeable formations, the nature of the invaded zone. It is not feasible with present measuring procedures to eliminate these effects; however, the influence of bed thickness on apparent resistivity is negligible if the formation is many times as thick as the AM spacing of the "normal" curve or several times as thick as the AO spacing of the "lateral." The other factors noted above can be taken into account and true resistivity determined from the apparent resistivity by the use of resistivity-departure curves.

The electric-log resistivity or apparent resistivity is satisfactory for all problems except the determination of the fluid content of permeable zones. The true resistivity required for this latter work may be obtained from the departure curves or sometimes directly from the long normal or lateral curve.

Experience and research have proved the general over-all utility of the multielectrode method for making resistivity measurements, as it minimizes the effect of the drilling fluid and the well bore, and it makes possible a direct comparison of the several recorded resistivity curves. Multielectrode recording, as distinguished from single or point-electrode measurements, is made with a system of four electrodes; two of these are current emitting and two are for potential measurement. The curves recorded are termed "normal" or "lateral," depending upon the electrode arrangement.

Terminology

Electrodes.—The current electrodes are designated "A" and "B," the meas-

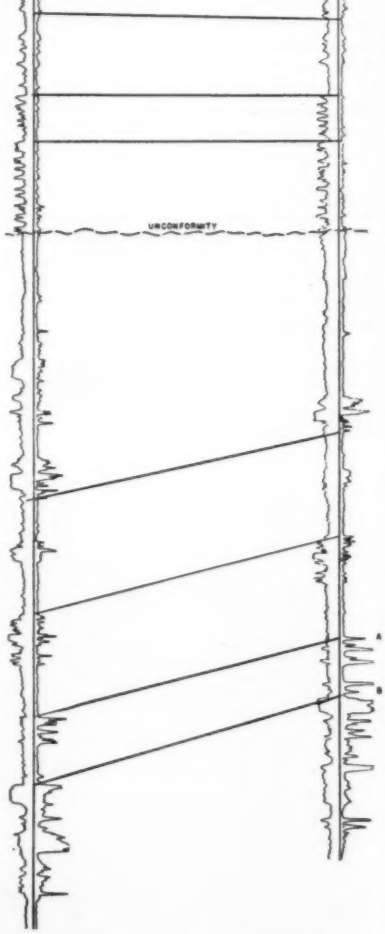

Fig. 12—How electric logs are used for correlations.

uring electrodes "M" and "N." Common practice is to have the two current electrodes, A and B, and one potential-measuring electrode, M, in the hole with the other potential electrode, N, at the surface. Some of the electrodes in the hole are mounted on a mandrel, called a "sonde," which serves as a guide and weight for the cable.

Normal curve.—A normal curve is a resistivity log recorded with the four-electrode system where the distance between one current and one potential-measuring electrode, AM, is of primary importance. The position of the other current electrode, B, is relatively unimportant as long as the distance, AM, is small as compared to AB.

Amplified normal curve.—A resistivity log recorded with the normal-curve-electrode arrangement but using an amplified or exaggerated scale is an amplified normal curve. For example, the normal curve might be recorded on a 20-ohm scale, the amplified normal with a 4-ohm scale.

Long normal curve.—A long normal curve is a resistivity log recorded with the same electrode arrangement as the normal but with the distance, AM, several times as great as the normal.

Lateral curve.—A resistivity log recorded with the four-electrode system, where the distance between one potential-measuring electrode and a point midway between the two current electrodes, AB, is of primary importance, is a lateral curve. The distance AB is small as compared with the distance AM.

Long lateral curve.—A resistivity log recorded with the same electrode arrangement as the lateral but with the distance between M and the midpoint of AB longer than that of the regular lateral is a long lateral curve.

Electrode Spacing

Normal curves.—The spacing is considered as the distance, AM, between the current electrode, A, and the potential-measuring electrode, M. Depending upon the geologic province, this spacing varies between 8 and 18 in. for the normal curve and between 5 and 6 ft. for the long normal curve.

Lateral curves.—The spacing is considered as the distance between the potential-measuring electrode, M, and a point midway between the two current electrodes, AB. This spacing is always large as compared with the distance, AB.

Depth of investigation.—The depth of investigation is an indefinite matter since, for both the normal and lateral arrangement, it varies with many factors. It can be stated, however, that in general the greater the AM or AO spacing the greater the depth of investigation.

Characteristics of resistivity curves. A resistivity log has primarily a twofold purpose: one, to locate and determine the boundaries of all resistive formations; the other, to determine the fluid content, both qualitatively and quantitatively, of permeable formations. The first condition, with a normal curve, is achieved best by a short electrode spacing, AM; the second, by using a longer electrode spacing in order to minimize the effects of the drilling fluid, the diameter of the hole, and the invaded zone. As a result two or more resistivity curves, one with a short spacing and others with a somewhat longer spacing, are commonly recorded and presented on each log.

The particular behavior of normal curves in resistive beds of various thicknesses is illustrated in Fig. 9. It is to be noted especially that a resistive bed equal to the electrode spacing gives no indication; a resistive bed which thickness is less than the electrode spacing is shown as an inverted anomaly.

The lateral-type curve, with the spacings commonly employed, is usually adequate to minimize the effect of the invaded zone and, at the same time, to indicate the position of resistive zones. Fig. 10 indicates the behavior of the lateral curve with resistive beds of different thicknesses. Note that it shows beds of all thicknesses, but that the top boundary of formations whose thickness is greater than the AO spacing is indefinite, and true values are shielded out for a distance equal to the AO spacing. The actual thickness of beds less than AB is exaggerated by an amount equal to the distance between the current electrodes. Below thin resistive beds an abnormally low resistivity is measured for a distance equal to the AO spacing regardless of the nature of the formation opposite the section (Fig. 11).

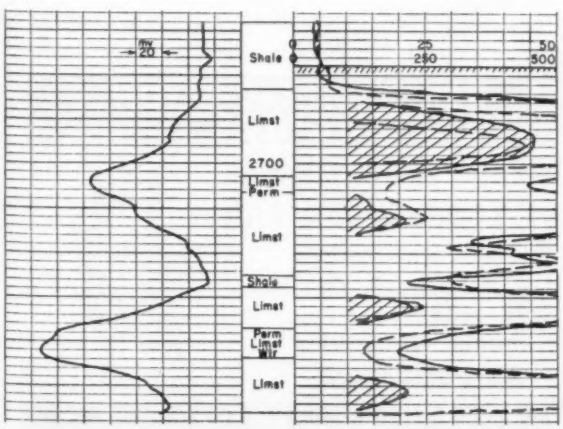

Fig. 13—Common characteristics of an electric log in limestone.

Application of the Electric Log

Correlation.—The utility of the electric log in detailed structural pool studies or in general stratigraphic investigations is well known. Fig. 12 is a typical correlation study in the Mid-Continent area.

Distinction between porous and permeable formations and nonporous and nonpermeable formations.—The spontaneous-potential curve usually indicates permeable formations containing saline interstitial water by a marked negative anomaly. This characteristic is common for sands as well as limestones or dolomites and for shallow as well as deep formations. Formations containing fresh interstitial water, on the other hand, are usually indicated by their lack of S.P. anomaly or by a positive anomaly.

An electric-log analysis through a limestone or cemented-sandstone section, where permeable zones occur interbedded with otherwise nonpermeable beds, needs particular mention. The permeability zones, whether oil or water-bearing, are usually more conductive (less resistive) than the surrounding nonpermeable formations because of the saline interstitial water. The resistivity log exhibits, therefore, a lower value across permeable zones than across the nonpermeable ones (Fig. 13). The anomalies on the SP log spread above and below the permeable beds to such an extent that permeable-zone boundaries are not determined easily by a cursory examination.

Location and exact depth of all formations.—A stratigraphic log is obtained indicating the presence and depth position of all formations. This practically eliminates the possibility of passing up a potentially productive oil or gas-bearing formation.

Sand studies.—Changes in the physical characteristics of reservoirs can be studied, aiding the solution of many exploration and production problems.

Determination of thicknesses.—The thicknesses of all formations can be determined, and the net producing thickness of sand reservoirs can be calculated.

Fluid-content determinations.—It is possible in most cases to distinguish between an oil or gas reservoir and a water-bearing formation; in many sand reservoirs a quantitative determination of the percentage of void space containing oil or gas or, conversely, the percentage of void space containing interstitial water can be made.

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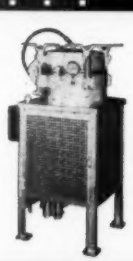

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7. Induction Logging

MEASUREMENT of the resistivity of the formations traversed by drill holes has become standard practice in oil-well drilling during the last 20 years. The technique used requires that direct contact be made with the mud filling the bore hole by means of electrodes connected to the insulated conductors of the supporting cable. A current of constant intensity is generally made to flow in the surrounding medium through one or two of these elecrodes called "power electrodes." It produces in the surrounding medium, by ohmic effect, potential differences which are proportional to its average resistivity. These potential differences are picked up by one or more measuring electrodes and are recorded continuously at the surface of the ground, giving the resistivity log.

There are cases, however, where a direct contact between the electrodes and the drilling mud is not possible; for instance, in holes drilled with cable tools, which are generally dry, or in holes where nonconductive oil-base mud is used in rotary drilling. The conventional electric-logging method then requires scratcher electrodes, which are forced by springs on the wall of the hole to make direct contact with the formations. In some cases the results are fairly satisfactory, but sometimes, particularly in wells drilled through hard formations, the measurements are not reliable because of poor contacts with the formations. It is particularly for that reason that a new method of electric logging, known as "induction logging," has been introduced for resistivity measurements in oil-base mud.

The induction-logging system does not require any direct contact with the mud or with the ground. As indicated by the name of the method, the formations surrounding the logging apparatus are energized by induction. As in regular logging with eltctrodes, the signal is recorded continously at the surface of the ground while the apparatus is moved along the hole. The record thus produced, which is frequently called an "induction log" because of the way in which it is obtained, shows the variations of the ground conductivity—and, consequently, of its inverse, the ground resistivity—with respect to depth. It is, therefore, equivalent to the resistivity log obtained by the conventional method of electric logging with electrodes in water-base mud.

The advantages of the method are more immediate, especially in view of the difficulties encountered by the conventional method of electric logging. This does not mean that the induction-logging method will not work in water-base mud; on the contrary, it is believed that in that case also the method will have important advantages. Experience in water-base mud is, however, still very limited, not only because the available instruments were all applied to oil-base-mud operations, where they were badly needed, but also because certain improvements, which are still being studied, are to be introduced for best operation in water-base mud. This is why it is felt advisable not to discuss the use of induction logging in water-base mud at this time and to wait the results of field tests that will be made for that case.

An important advantage of the induction-logging system is that the measured values, even without corrections, are already nearer to the true values; furthermore, the corrections themselves are much easier to compute than in the case of logging with electrodes, particularly when influence of bed thickness is to be taken into consideration.

Geometry of Induction Logging

In the logging method using electrodes for the determination of the

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ground resistivity the flow of current is of the radial type, and it is not possible to study separately the influence of the different regions of ground surrounding the electrode system. The reason is that the lines of current flow across the boundaries between the different media, such as, for example, the boundary between a given bed and the bed next to it or the boundary between the mud and a bed. If the resistivity of any given medium is changed, this affects the lines of current flow even in their path through the other media. This is the reason that the mathematical computation of departure curves is rather complicated and can only lead to a fair approximation when the beds become thinner and more homogeneous.

In induction logging the situation is entirely different. If the hole is vertical, as will be assumed to simplify the discussion, the line of current flow are horizontal circumferences having their centers on the axis of the hole. Since there is generally a symmetry of revolution of the ground around the axis of the drill hole, each line of current flow remains in the same medium all along its path and never crosses a boundary between

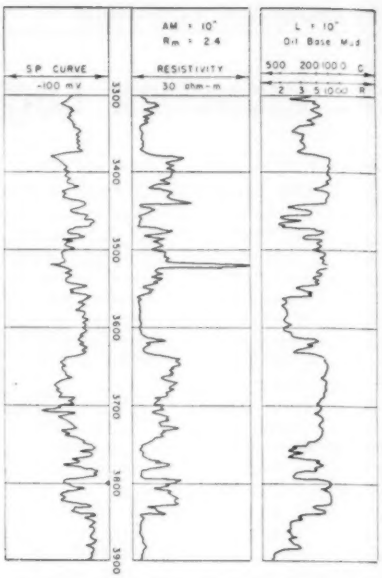

Fig. 1—Induction log (right) recorded in oil-base mud alongside a conventional electric log of the same well recorded in water-base mud.

media of different conductivities. On the other hand, if the frequency is not extremely high, the reaction of the different circular currents on one another can be neglected. In this condition, the action of the different regions of ground, which individually have a symmetry of revolution around the hole, can be considered separately, and the measured signal is simply the sum of the individual signals given by the different regions. The consequence is that the theoretical computation of charts or of typical logs corresponding to any distribution of ground conductivities is always possible, if, of course, there be a symmetry of revolution, as is usually the case.

Conclusion

The conductivity or the resistivity of formations traversed by a drill hole can be determined by the induction-logging method. This new technique is particularly useful at present for logging dry hole and holes filled with oil-base mud, in which direct contact with the formations is difficult to establish.

The method has great flexibility and is quite promising. Coil systems can be designed to give a focusing effect in order to obtain directly on the log a more accurate value for the conductivity of beds of finite thickness.

Since the different regions of ground generally have a symmetry of revolution around the axis of the hole and since, therefore, the induced currents have circular paths around that axis, the currents never cross the boundary from one region to the other. In these conditions the contributions of the different regions to the measured signal can be considered independently.

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8. The Microlog

IN conventional electrical logging, the spontaneous-potential (S.P.) log is used to delineate the permeable beds, and the resistivity logs are used primarily to provide indications concerning the fluid content of the beds.

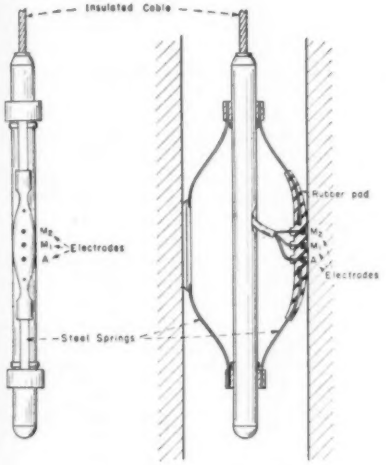

Fig. 1—MicroLog apparatus.

When the formations are much more resistive than the mud, as happens, for example, in limestone fields, the S.P. currents are short-circuited by the more conductive mud column, with the result that the S.P. log is quite rounded. In that case, the S.P. log generally gives the approximate location of the permeable formations, but it cannot be used for an accurate determination of the boundaries of each permeable bed.

Solutions for the problem of obtaining a better determination of the permeable beds in limestone fields were developed from two angles. One approach consisted in improvements of the logging of the S.P., as given by selective S.P. logging and static S.P. logging. These new methods give good results when the mud is not too salty; but they are still in a somewhat experimental stage, mostly because the development efforts have lately been concentrated on another approach to the problem, i.e., the MicroLog.

The MicroLog has been developed primarily as a means for the accurate determination of the permeable beds, where the S.P. log alone does not give a satisfactory answer. For that reason, this new development has found its first field of application in limestone areas, where the usefulness of MicroLog is most obvious. The MicroLog is, however, also of importance in sand and shale formations, if only for a more precise determination of the boundaries between successive beds, and for a better evaluation of the sand count.

Principle of MicroLog

A MicroLog is a resistivity log recorded with electrodes spaced at short distances from each other in an insulating pad which is pressed against the wall of the drill hole. Under those conditions, the system measures the average resistivity of the small volume of material—hereinafter referred to as a "microvolume"—which is located under the pad, and which is, therefore, electrically shielded against the short-circuiting action of the mud.

Two different electrode systems, with different depths of investigation, are generally used in combination to provide two logs that are recorded simultaneously. For both electrode systems, the spacings are very small—usually 1 or 2 in. In the discussion, the systems which have the smallest and the largest depth of investigation are respectively referred to as the "short spacing" and the "long spacing."

When the pad is applied to a permeable bed, the mud cake represents a substantial proportion of the microvolume. Inasmuch as the mud cake has a resistivity of R_{mc} which can be estimated to be only about twice the resistivity R_m of the mud, the resistivities recorded through MicroLog—hereinafter referred to as microresistivities—are never very high opposite

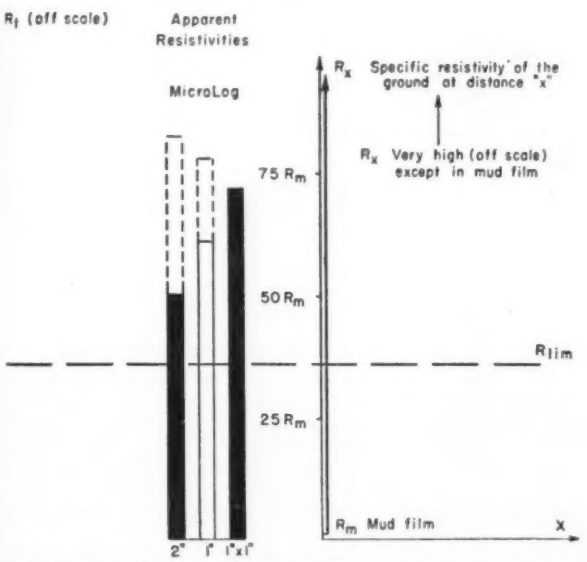

Fig. 2—Impervious formation of high resistivity with a mud film of 1/64-in. thickness.

Fig. 4—Permeable bed (oil-bearing) invaded by mud filtrate (category P_2).

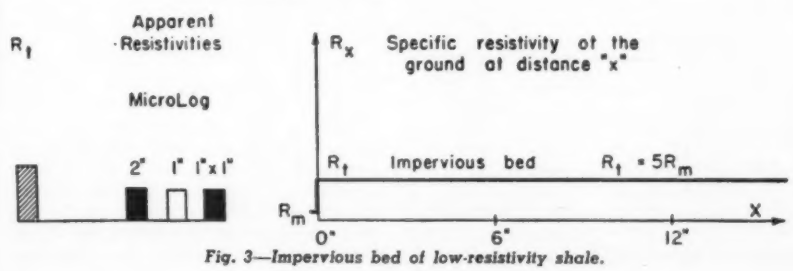

Fig. 3—Impervious bed of low-resistivity shale.

permeable beds, and are appreciably related to the resistivity of the mud. The other part of the microvolume is constituted by a fraction of the solid structure of the permeable bed whose pores are almost completely filled by the mud filtrate. The resistivity of that part of the microvolume is, therefore, not much different from the value $F \times R_m$ which corresponds to complete mud filtrate saturation, so that it is also directly related to the resistivity of the mud.

It easily can be deduced from these considerations that the microresistivities measured opposite a permeable bed cannot generally be higher than a certain number of times the resistivity of the mud, unless the mud cake is very thin, and unless, simultaneously, the formation factor F is very high. A corresponding limit R_{xlm} can be set at about 20 or 30 times the resistivity of the mud for the average case; therefore one of the rules of interpretation for the MicroLog is to classify as most probably impervious all formations for which the microresistivities are higher than a certain limit R_{xlm} directly related to the resistivity of the mud.

Because of a smaller depth of investigation, the short spacing is more influenced by the mud cake, and, therefore, generally gives a smaller apparent resistivity than the long spacing. This difference between the microresistivities recorded using two different depths of investigation is called "departure," and is said to be positive when the longer spacing gives the larger resistivity. When there is a large percentage of "positive departure," the formation can almost certainly be interpreted as permeable.

When the pad is applied to an impervious bed of low resistivity, both spacings measure substantially the same resistivity, which is that of the formation, and there is no appreciable departure between the microresistivity curves. If the resistivity of the impervious bed is very high, the microresistivities can differ appreciably from the formation resistivity, but they are both higher than the limit R_{xlm} above which beds should be classified as impervious. For intermediate values of the resistivity, and because of the limited dimensions of the pad, a departure between the microresistivity curves is sometimes observed on impervious beds; but, in that case, the departure is negative; i.e., the longer spacing gives the smaller value of the apparent resistivity, so that there can be no confusion in the interpretation.

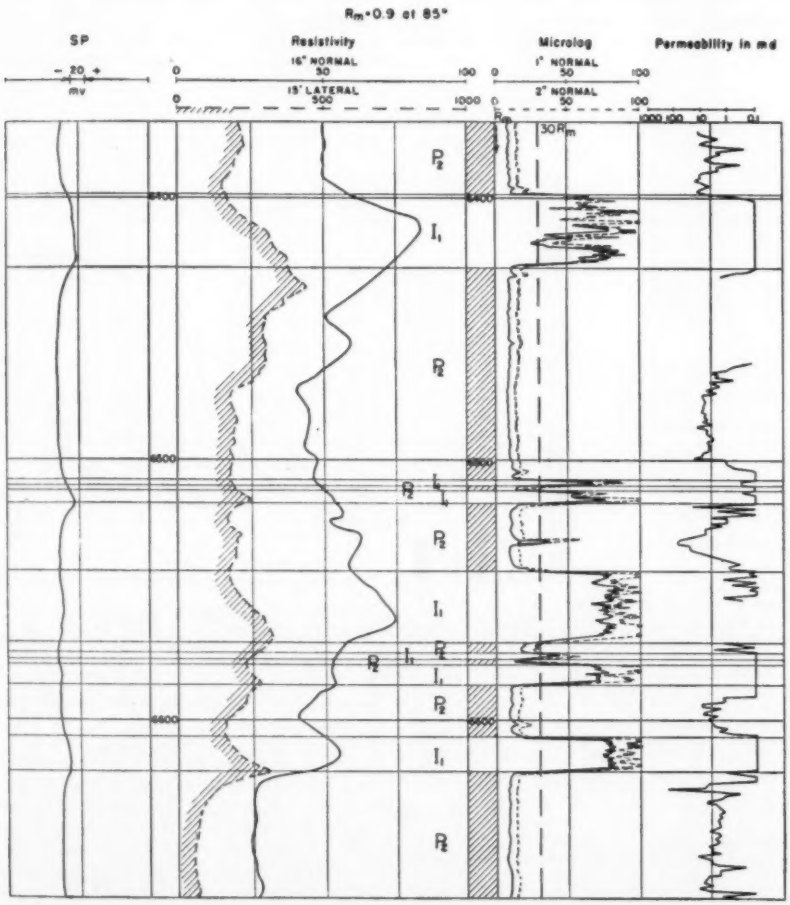

Fig. 5—MicroLog recorded in sequences of shales and limestones.

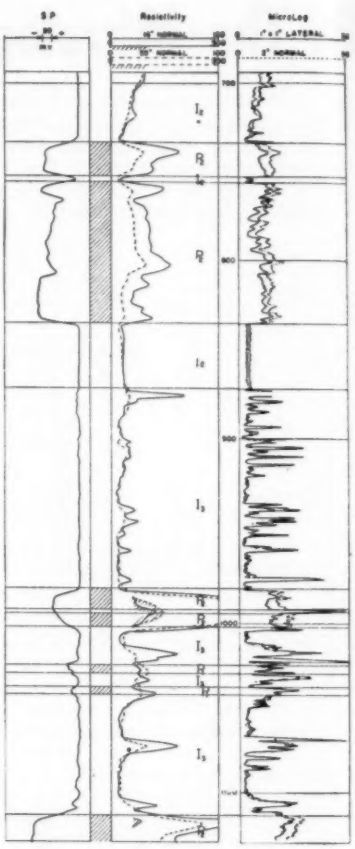

Fig. 6—MicroLog recorded in sequences of sandstones, limestones, and shales.

Interpretation of MicroLogs

A discussion of the interpretation of the MicroLogs will be aided by placing the different cases usually encountered in practice into categories. Each category will be given a reference letter, namely, I_1, I_2, I_3 (Impervious beds), P_1, P_2 (Permeable beds).

Highly resistive impervious formations (Category I_1). — In impervious formations of high resistivity—i.e., whose resistivity is, for example, more than 50 times that of the mud—all the microresistivities are high. Because the wall of the drilled hole is generally somewhat rugose, the rubber pad cannot fit perfectly against it, and a sort of mud film may remain between the two. For that reason, and also because of the limited dimension of the rubber pad, the apparent resistivity recorded on the MicroLogs can be substantially lower than the true resistivity for that type

of formation. When the formation resistivity is very high, the rugosity of the wall, which causes a mud film to remain under the pad, almost entirely controls the microresistivities. Too much importance should, therefore, not be attributed to the absolute values determined for the microresistivities, nor to the amount and type of departure between the two curves.

The diagnostic is based in this category on the fact that all microresistivities are superior to a certain limit $R_{t\,lim}$ which, as said before, can be taken equal to about 20 or 30 times the resistivity of the mud in the average cases. Such high microresistivities on both MicroLogs could not normally be recorded for a permeable formation. Both the invaded zone of the permeable formation and the mud cake would contribute to lower the apparent resistivity on the MicroLogs, and keep at least one of them, the 1 by 1-in. lateral or the 1-in. normal, under the limit $R_{t\,lim}$.

The case of a compact bed of high resistivity is illustrated in Fig. 2, where it is supposed that the formation is more than 200 times as resistive as the mud, and that there is, between the pad and the formation, a uniform mud film 1/64 in. thick. The order of magnitude of the different microresistivities is about the same, but there can be a slight departure, either positive or negative, depending on the shape of the pad, the rugosity of the wall, the ratio of formation resistivity to mud resistivity, etc.

Impervious beds of low resistivity (Categories I_2 and I_3).—Fig. 3 represents an impervious bed whose resistivity has been assumed to be five times the resistivity R_m of the mud. The resistivity diagram on the right of the figure illustrates the fact that the resistivity is uniform and does not vary with the distance from the pad, as would occur for a permeable bed. This diagram also shows the resistivity scale in relation to the resistivity R_m of the mud.

The rectangles at the left of Fig. 3 represent, at the same scale, the respective values of the different microresistivities that would be obtained in that case and the formation resistivity R_t. The apparent resistivities measured on the different microresistivity logs are slightly lower than the true resistivity R_t of the formation because of the limited dimensions of the pad.

When the resistivity of the impervious bed is not much different from that of the mud, there is practically no departure between the microresistivity curves (Category I_3). When, on the contrary, the resistivity of the impervious bed is appreciably higher than that of the mud, there is generally, at least with the pads presently used, a substantial negative departure which is characteristic of an impervious bed (Category I_3).

Permeable beds (Categories P_1 and P_2).—At the level of a permeable formation, the rubber pad slides over the mud cake against which it is applied, and the mud cake itself is separated from the uncontaminated part of the formation by the invaded zone, wherein the original fluid has pro-

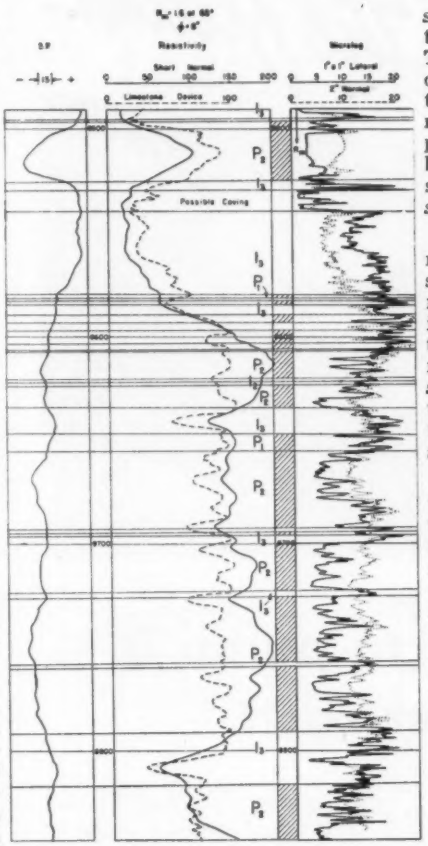

Fig. 7—Example of MicroLog in vugular limestone.

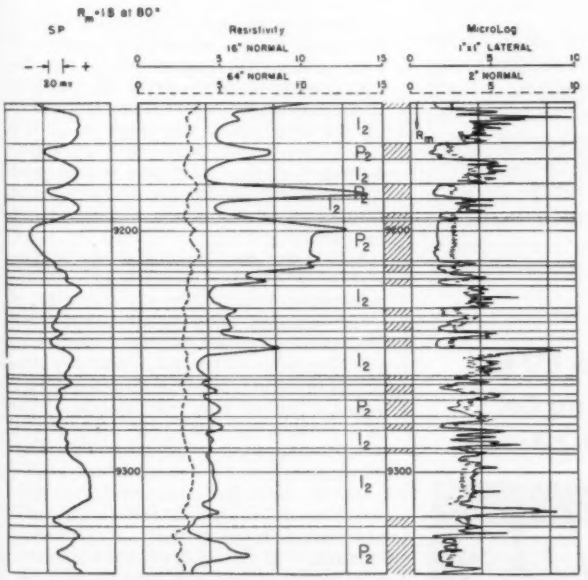

Fig. 8—Illustrating features of MicroLog in sequences of nonconsolidated sands and shales.

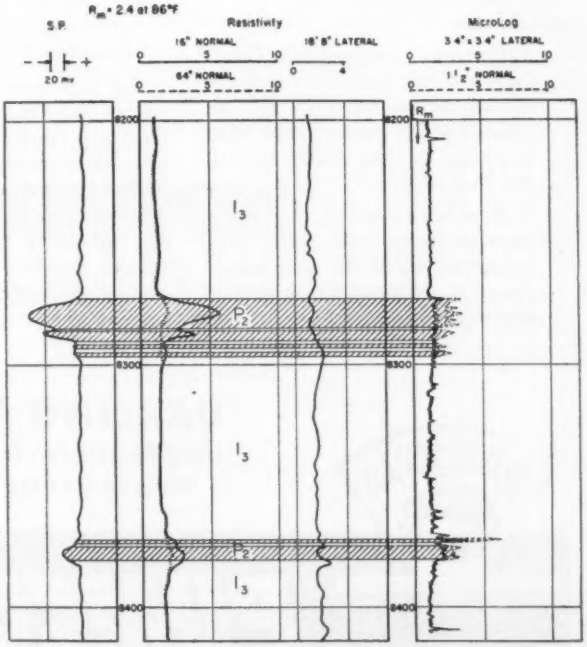

Fig. 9—Example of MicroLog in shaly sandstone.

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gressively been replaced by mud filtrate.

Two cases must here be considered, depending on whether the invaded zone is less or more resistive than the uncontaminated zone.

The first case, which is the simplest as far as interpretation of the MicroLogs is concerned, is represented in Fig. 4, which is similar to Fig. 3 already discussed, except that now the resistivity varies in the formation with the distance from the pad. Here again, the abscissas on the diagram represent the depths from the pad, while the ordinates show the resistivity of the ground at the corresponding depths.

The resistivity R_{mc} of the mud cake has been assumed to be twice the resistivity R_m of the mud. The resistivity R_{xo} immediately behind the mud cake, where the permeable bed should be practically saturated by mud filtrate, has been taken equal to 10 times R_m; this would correspond to a value of 10 for the formation factor, if the saturation by mud filtrate is complete, and if the pores are reasonably free of conductive solids.

On the left of Fig. 4 are represented, at the same scale, the approximate values of the microresistivities that would be obtained in that particular case from the Microlog. As can be seen, the departure is positive and quite substantial. This result is general when R_t is larger than R_{xo}. A large positive departure between microcurves is characteristic of a permeable bed, provided, however, that the resistivity measured by the 1 by 1-in. lateral, or by the 1-in. normal, be lower than approximately 30 times that of the mud (Category P_2).

The interpretation is less definite for beds, such as salt-water-bearing beds, where the resistivity of the invaded zone is larger than that of the uncontaminated zone. This is particularly true when the mud is of the low-water-loss type, with the consequence that the mud cake is thin and the formation is invaded by the mud filtrate to only a short distance from the wall.

When the mud cake has an appreciable thickness, and when, simultaneously, the depth of invasion is large enough, the microresistivities measured with the different electrode combinations show good positive departures (Category P_3). For a smaller penetration of the mud filtrate into the permeable bed, the departure would disappear (Category P_1). For still less invasion, the departure might even be slightly negative, but this negative departure never exceeds 20 per cent (Category P_4).

When the departures between the microresistivities are small, nil, or slightly reversed (within 20 per cent), the interpretation can be aided by

the fact that these microresistivities are larger than the formation resistivity, contrary to what would normally happen for an impervious bed of low resistivity, as discussed in connection with Fig. 3. It is simpler, however, to refer to the S.P. log to resolve the ambiguity in this case.

In all the cases represented in Figs. 2, 3, and 4, the microresistivity corresponding to the 1 by 1-in. lateral could be computed with reasonable accuracy. The microresistivities corresponding to the 1 and 2-in. normals are only approximate, because the effect of the limited size of the pad cannot be accounted for accurately with these devices.

It is interesting to notice that the microresistivity for the 1 by 1-in. lateral is the same for the different cases represented on Figs. 2, 3, and 4, which cases differ only by the value of true resistivity R_t and the depth of invasion by the mud filtrate. This illustrates the fact that the microresistivities, when measured with an electrode combination having a very small depth of investigation, are essentially responsive to the resistivity R_{x_0} of the invaded zone and to the thickness and resistivity of the mud cake.

Rules of Interpretation

From the above discussion, it is possible to derive a certain number of simple rules of interpretation for the microresistivity logs of formations, whereby two electrode combinations of different depths of investigation have been run simultaneously.

Case 1.—The two microresistivities are higher than $R_{1\text{-}1m}$, that is, higher than about 20 or 30 times the mud resistivity. The formation then under study is a compact one, and should be interpreted as impervious, regardless of the departure (Category I_1).

Case 2.—The microresistivity determined by the shorter spacing, generally 1 by 1-in. lateral, is smaller than the limit $R_{1\text{-}1m}$. In that case, the sign and magnitude of departure should be examined, and, in case of doubt, the ambiguity resolved by reference to the S.P. log. This gives the following interpretation categories:

(a) Large negative departure (more than 20 per cent)—the formation is impervious (Category I_2).

(b) The departure is not definite enough (less than 20 per cent)—the MicroLog alone cannot determine, in general, whether the formation is permeable or not in this case, except that, when the resistivity of all formations are known to be much higher than that of the mud, the fact that the microresistivities are comparatively low gives a good probability that this is due to mud infiltration in a permeable bed. The ambiguity, if any, can be resolved by noting the trend of the S.P. curve. If that

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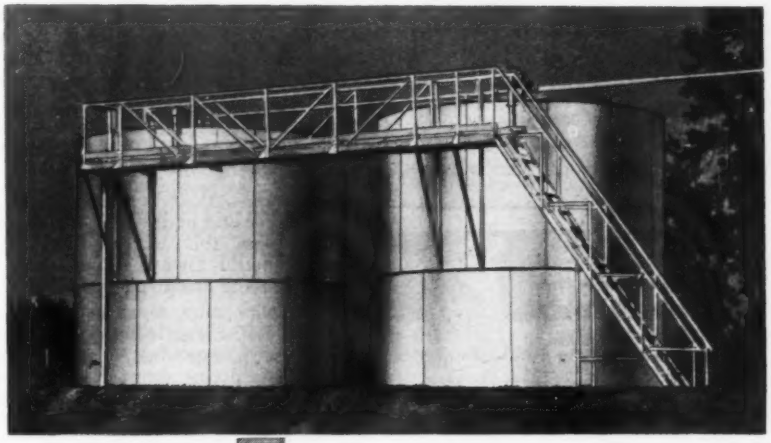

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trend is positive, i.e. if the convexity is toward the positive side, or if the S.P. is on the positive limit (shale line), then the bed must be interpreted as impervious and the MicroLog gives its exact boundaries (Category I_3). If, on the contrary, the trend of the S.P. log is negative, the bed is permeable, and again the MicroLog gives the accurate boundaries (Category P_3).

(c) Large positive departure (more than 20 per cent) — the formation must be permeable (Category P_3).

Remarks.—(1) It is indeed wise to check the trend of the S.P. log in any case; unless this log is completely flat, it should always be possible to determine the trend of the S.P.

When the mud is saturated with salt, the S.P. curve is completely flat. In that case, however, there is generally little doubt about the interpretation of the MicroLog, because the permeable beds, which are invaded by the saturated mud filtrate, are the only ones to give microresistivities lower than the limit R_{t1m}, which itself is lower than the true resistivity of all impervious beds. The interpretation can then be based on the observation of the lows in the MicroLog, while a good positive departure, if it exists, brings a useful confirmation.

(2) The interpretation is also facilitated by the consideration of the conventional resistivity log, insofar as this log makes it possible to evaluate the true formation resistivity R_t.

When the value of the microresistivity R_{micro} is less than R_{t1m}, it can reasonably be assumed that a bed cannot be impervious unless R_t is comprised between values respectively equal to about R_{micro} and 2 R_{micro}. When R_t is between the two values, the S.P. log will generally give a definite anomaly that will make the interpretation safe. When R_t is not between the above limits, there is a strong probability that the bed is permeable.

(3) In the particular case of a highly resistive permeable bed, with a comparatively conductive invaded zone, and interbedded with shales and highly resistive compact formations, the S.P. log may show no appreciable deflection with respect to the shale line. But, in that case, a good correct departure should be obtained from the MicroLog.

Exceptions to the rules.—There are few cases which do not fall within the simple set of rules discussed in the previous section. Fortunately, these cases are rare, and the ambiguity can generally be resolved if the remarks made in the previous section are taken into account.

A first exception, which is obvious, corresponds to cavings whose diameters are larger than the maximum expansion of the spring system. If, in such a case, the pad remains a few inches from the wall, the two microresistivities will be equal to the resistivity R_m of the mud, irrespective of what the formation is. If, on the contrary, the pad happens to be near to the wall, the 1 by 1-in. lateral will measure approximately the resistivity of the mud, whereas the 2-in. normal will already be substantially affected by the formation resistivity. Inasmuch as the formation resistivity is usually higher than that of the mud, even for a conductive shale, there will be a positive departure between the MicroLogs which could be falsely interpreted as indicating a permeable bed. These two cases can generally be detected by observing the abnormally low value given by the short spacing (1 by 1-in. lateral) for which the microresistivity is frequently close to R_m in that case, and they would not fail to be recognized if a section-gage log were run, as is highly recommended when large cavings might exist. In those cases, the MicroLog indications should be disregarded, and the interpretation based on the conventional log and, in particular, on the S.P. log, as far as the determination of the permeable beds is concerned.

The interpretation rules could also be at fault if the mud cake, instead of being built on the wall, and within the hole, were built within the pores of the permeable bed. This case has not been encountered yet, but it seems that it could occur in coarse-

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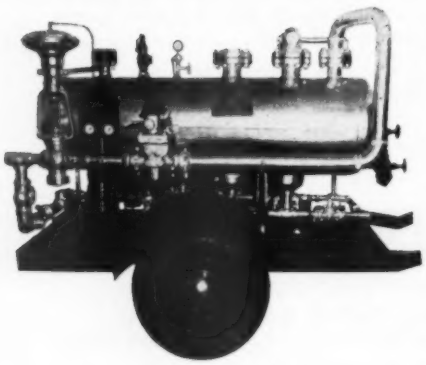

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grain sands. If that did happen, the part of the permeable bed where the pores are filled with the mud deposit would be a little more resistive than the invaded zone behind, with the result that the 1 by 1-in. lateral would measure an apparent resistivity slightly higher than that measured by the 2-in. normal. This would result in a negative departure, and the bed might, therefore, on the basis of the MicroLog, be falsely classified as impervious. Here again, the S.P. log would generally settle the question.

Other exceptions, which have not yet been observed, may exist and will reveal themselves when more examples are acquired. For that reason, it will always be useful to confront the indications given by the MicroLog with those obtained from the S.P. log, and also from the conventional resistivity logs, supplemented by the section-gage log when large cavings are to be expected.

Field Examples

Fig. 5 shows an example of a MicroLog recorded in a sequence of shales and limestone. In this instance, most of the compact beds give rise to microresistivities which are definitely higher than 30 R_m, so that the discrimination between permeable and impermeable formations is particularly easy. The permeability record, provided by core analysis, was available in this hole and is reproduced in the figure as a check on the indications of the electrical logs.

In Fig. 6, sequences of sands, sandstones, limestones, and shales are exhibited.

Fig. 7 shows the behavior of the MicroLog in the case of a thick limestone formation (Ellenburger), composed of compact zones and of fissured zones with vugular porosity.

Figs. 8 and 9 illustrate the features of the MicroLog in sequences of nonconsolidated sands and shales, such as those commonly encountered in the Gulf Coast or in analogous geological provinces. In these regions, the conventional S.P. and resistivity logs differentiate very well the different sections where sands or shales are respectively predominant, but they are not capable of delineating each separate sand or shale streak, if these are thin. A very detailed record of the individual permeable and impervious beds is obtained from the MicroLog, as shown on the figures. This result is of interest for an accurate determination of the proportion of shale and sand in shaly sands, or, in colloquial terms, for the evaluation of the sand count.

Quantitative Interpretation

To date, the MicroLog has been used primarily for a qualitative determination of the permeable beds and an accurate determination of their boundaries. It must be kept in mind, however, that the microresistivities measured for permeable beds are largely dependent on the resistivity and thickness of the mud cake, and on the resistivity R_{x_o} of the formation immediately behind the mud cake. It is possible that the developments presently under way could bring the MicroLog equipment to a point where R_{x_o} and the thickness of the mud cake could be determined quantitatively.

9. Radioactivity Well Logging

RADIOACTIVITY well logging as practiced commercially in the United States and South America is at the present time composed of two curves, the gamma-ray curve and the neutron curve.

The gamma-ray curve is a relative measurement of the natural radioactivity occurring in the strata of the earth. Minute quantities of radioactive materials in one form or another are universally distributed. Measurable quantities are found in all kinds of igneous, metamorphic, and sedimentary rocks. From laboratory measurements and the experience gained in logging more than 15,000 wells, certain conclusions can be drawn concerning the relative intensity of radioactivity in different kinds of sedimentary rocks. Fig. 1 is a chart that demonstrates the relative radioactivity values of various formations encountered in well logging. Anhydrite, salt, and coal are very low in radioactivity, while shale, bentonite, ash, and organic shale have the highest values of radioactivity encountered. Producing formations such as sand, limestone, and dolomite are relatively low in radioactivity.

The neutron curve might well be referred to as a "fluid content or hydrogen curve," since hydrogen is the controlling factor on the action behavior of the curve in well logging. Neutron well logging is the process of bombarding the strata with a strong source of fast-moving neutrons and recording the secondary gamma rays that have been excited by the neutron bombardment. Where hydrogen is present in the strata, the neutrons are slowed down or stopped, and this in turn gives a low value on the curve. Where there is no, or very little, hydrogen present, the response is quite high in value and is shown as a throw to the right.

Interpretation

Any well log must be interpreted in terms of geology and stratigraphy before its utility can be realized. Because the proper interpretation of a radioactivity well log will identify the various formations represented on the log and determine their characteristics and extent, such interpretation

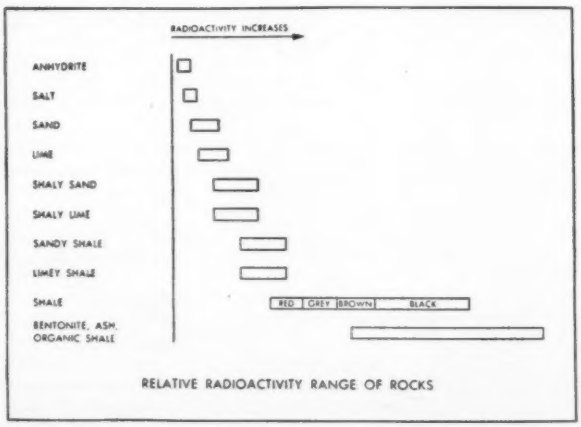

Fig. 1—Chart indicates radioactive values of various formations.

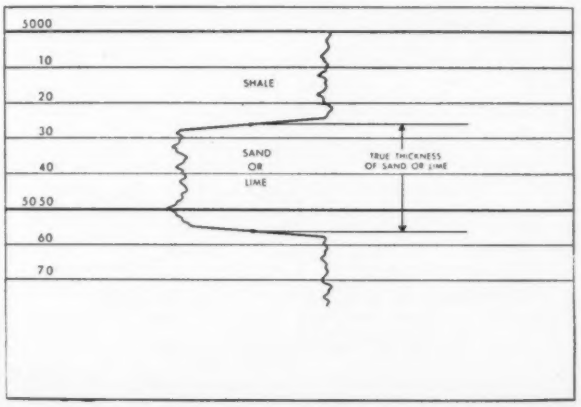

Fig. 2—Method of determining true thickness of sandstone or limestone using midpoint of transition for top and bottom of zone.

necessarily involves a wide variety of both geology and bore-hole conditions. The fact that these factors do vary widely from well to well and from field to field requires that theory be supplemented by wide experience and empirical knowledge to derive the most reliable log interpretation. The interpretation data that follow represent a summary of extensive radioactivity-well-logging experience. They the based on the behavior of gamma-ray and neutron curves under the geologic and bore-hole conditions most commonly observed. An important part of the correct interpretation of any log is the accurate determination of the tops and bottoms of formations. This procedure requires particular attention for radioactivity well logs because of the characteristically sloping transitions, which represent formation contacts.

Fig. 2, which is a portion of a gamma-ray curve, represents the correct point for determining the top and bottom of a zone. In all cases, regardless of the magnitude of the break, the midpoint or center of a minimum-maximum intensity value on the curve will most reliably indicate the actual formation contact. Shown previously in Fig. 1 is the relative radioactivity range of the rocks encountered in oil-well logging. A working knowledge of the local stratigraphy is necessary for the correct geologic interpretation of the gamma-ray curve.

The shade or color of the rock has a relationship to the amount of radioactivity. The darker the shade or color, the higher the radioactivity, except for rocks stained by oil or asphalt. One notable exception is coal, which is very low in radioactivity.

A knowledge of the local stratigraphy is imperative for the correct interpretation because sandstone, limestone, and dolomite have so nearly the same value that they cannot be accurately differentiated by gamma-ray evaluation alone. Also in some areas of complex geology some sandstone and/or limestone have been encountered that are as high in radioactivity material as the usual shale. This phenomenon has occurred only in some Gulf Coast and California areas; none has been logged in Mid-Continent fields.

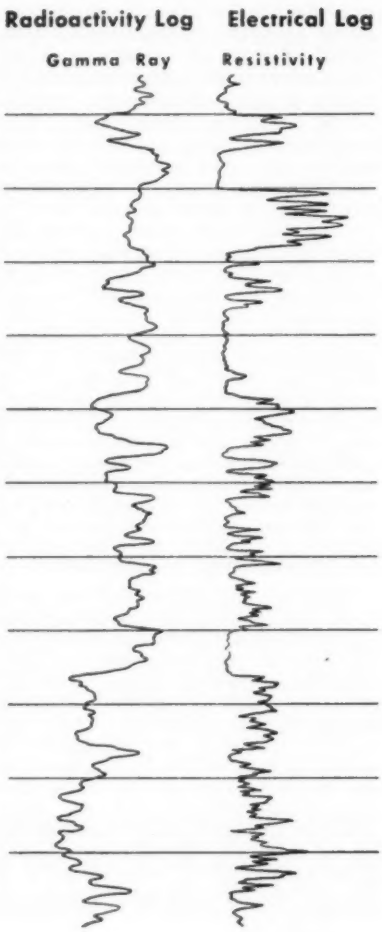

Fig. 4—Comparison between a gamma ray curve and an electrical resistivity profile taken 4 years previously in same well.

Neutron-curve interpretation is a matter entirely different from gamma-ray interpretation. It has been stated previously that the response of the instrument is controlled mostly by hydrogen. Response of the instrument opposite hydrogen is very low. It matters not in what form the hydrogen occurs, whether in gas, oil, water, or shale, the curve is characterized by a low reading on the graph or to the left of the chart. For this reason a neutron curve used alone cannot be interpreted further than to show the presence or absence of hydrogen. However, the neutron curve used in combination with the gamma-ray curve can be interpreted to locate possible porous zones in producing strata very accurately.

In Fig. 3 a portion of a combination radioactivity log is shown with the gamma-ray curve to the left, indicating a productive limestone of considerable extent. The tops and the bottoms of the formations have been determined as previously explained by selecting the midpoint of the transition. The neutron curve shown on the right is also interpreted by selecting midpoints on the transitions. "Throws" to the right are considered barren or impervious strata, while "throws" to the left indicating the presence of hydrogen are considered to have fluid in place and are therefore interpreted as possible porous zones.

Applications

The radioactivity well log was originally developed with the thought

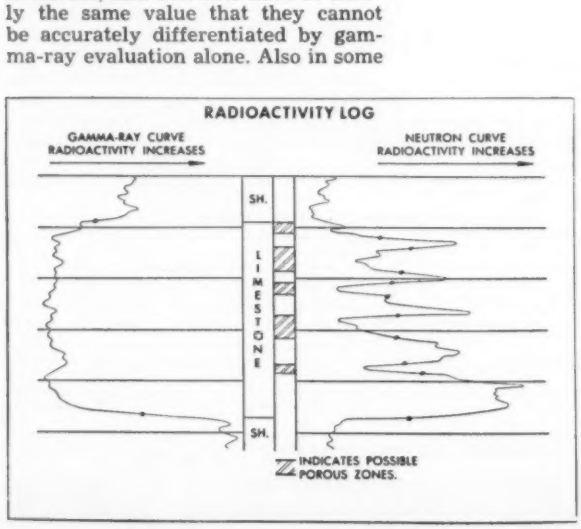

Fig. 3—This combination radioactivity log indicates productive limestone of considerable extent.

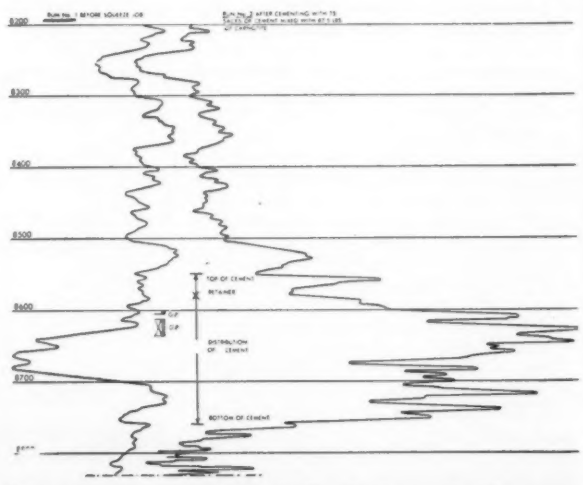

Fig. 5—Location of carnotite (radioactive) cement with gamma ray curve.

that some direct relationship might exist between natural radioactivity and the presence of petroleum. Experience to date indicates the absence of any such relationship. However, the indirect applications of the radioactivity well log to the location of petroleum reserves are numerous and varied.

The first advantage of the radioactivity well log over any other type of well-logging method is its ability to log through steel casing. This permits the stratigraphy study of old wells drilled prior to the development of geophysical well-logging methods now in common use. The location of upper cased-off potential producing zones has presented a logical field for this type of logging, particularly where no information was available or where the available information was doubtful.

Variations of this primary application are apparent. The location of the top of the producing zone for bottom-water shutoff, the correction of some of the earlier drillers' logs, the location of upper potential freshwater sands for salt-water disposal, the supplying of additional information where cores were not completely recovered or were lost, and the location of the top and bottom of an oil-producing zone for gas-oil-ratio control are all applications of this type.

Many logs are run for measurement checks of various kinds. Drill-pipe measure, casing measure, and electric-log measure often disagree. On many of the older wells the original zero point has been lost. On other wells, both old and new, a new bottom has been established. Many of the earlier sample logs did not take into consideration the time lag between the point of origin of the sample and the depth of the well at the time the sample was caught. Because of the tested accuracy of the measuring system employed and the ability of the instruments to indicate the changes in formations behind casing, radioactivity logs have become a popular means of resolving all manner of measuring discrepancies.

An additional feature of radioactivity well logging is the collar log, which is a record of the exact location of each casing collar. It is recorded electrically by means of a collar locator which is a component part of the gamma-ray instrument. Thus, the collar log is recorded simultaneously and on the same chart with the gamma-ray curve. This provides a permanent record of the fixed relationship of collars to formations. Formation tops and bottoms are accurately established in relation to the nearest casing collar. This combination eliminates the many measuring discrepancies that may occur in various means of well measuring.

The second advantage of radioactivity well logging is its ability to log in contaminated well fluids. In areas such as Central Kansas where salt beds are encountered in drilling, the resistivity of the drilling fluid is lowered to a point where it is impossible to get a good electric log. The high resistivity of fresh-water muds presents a similar problem in attempts to log fresh-water sands electrically. Oil-base mud is used in some areas to eliminate the infiltration where the productive zones are partly depleted or where bottom-hole pressures are low. Since oil is a dielectric substance, it shows a high electric resistance, which makes it difficult to obtain satisfactory electric logs. Electric logs have been run in oil-base mud by using electrodes that make a sliding contact to the walls of the well. However, washed-out places and irregularities in the well bore tend to defeat the purpose of the contact electrode and cause a curve to be produced that is sometimes difficult to interpret. Since the radioactivity well log is a measurement of radioactive emanations, it is not affected by salt-water mud, fresh-water mud, oil-base mud, or other contaminated fluids.

Radioactivity well logs are easily correlated with other types of geophysical well logs and such infor-

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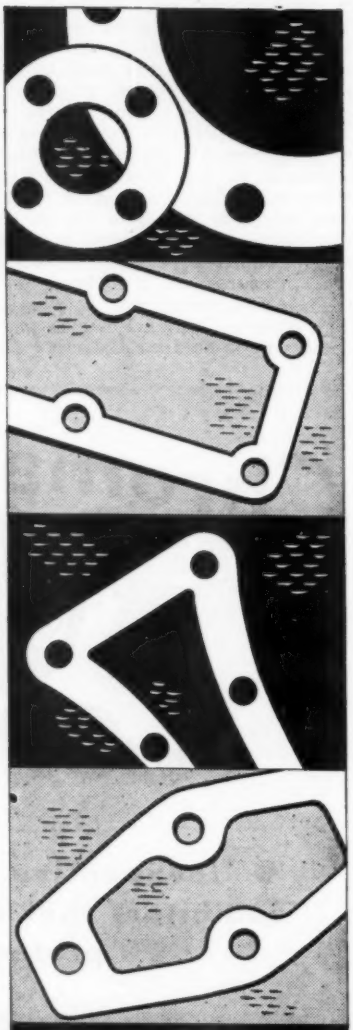

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mation obtained from well bores as sample logs and core analysis. Radioactivity logs and the types of electric surveys in common use today are easily correlated. Although there is no relationship between the two types of surveys and they are often surveyed under different well conditions or years apart, there still exists a similarity in response that permits accurate correlation. This is most fortunate, for it is simple logic to comprehend that a multiconductor cable such as is employed in electric logging used under varying fluid and mud conditions cannot be expected to measure with complete accuracy.

In making correlations between radioactivity and electric logs, the gamma-ray curve is correlated with the self-potential curve, while the neutron curve is compared with the shallow-resistivity curve.

Specialized Applications

Radioactivity well logs are also employed for a variety of specialized applications. One of these is the logging of added radioactive material. In the study of squeeze cement jobs on the Gulf Coast, it has been found desirable to know the vertical travel of the cement and its mass distribution behind the casing string. By means of a radioactive tracer such as carnotite mixed with cement, it is possible to determine the direction and extent of the cement travel. The usual procedure is to record a gamma-ray curve of the well under normal conditions. The mixture of carnotite and cement is then squeezed. After the cement has set and the plug has been drilled, a second gamma-ray curve is run on the same sensitivity as the first. The difference in gamma-ray intensity between the first and second runs is caused by the carnotite. Thus, by comparison of the two curves, the top and bottom of the cement travel can be determined. The same technique applies to squeezing of plastic material.

Another unusual application for radioactivity well logs is in the location of permeable zones in oil-producing horizons. The combination radioactivity log is run through the section to be studied. The gamma-ray curve provides the local stratigraphy, and the neutron curve indicates the possible fluid-bearing zones. A quantity of oil or water containing a radioactive tracer is then spotted opposite the section to be studied. Pump pressure is applied to force the radioactivity fluid into the producing horizon. A second gamma-ray curve is then run on the same sensitivity as the original run. The presence of the radioactive tracer in the zone increases the radioactive valuation of the zones and the relative permeabilities of the zones can be estimated by a comparison of the two gamma-ray curves.

10. Caliper and Temperature Logging

THE use of caliper and temperature records are sometimes so interrelated that a discussion of one log presupposes a discussion of the other. Here, however, for purposes of clarity, the records and the tools used to obtain them are treated separately.

Caliper Logging

One of the factors influencing the development and use of the rotary drill was its ability to cut through young, unconsolidated sediments and still have the bore hole tend to stand up. Nevertheless, numerous problems connected with rotary drilling and oil producing were a direct result of hole caving in rotary holes. The exact nature and extent of this caving was unknown. Every driller and every geologist had a theory, but there was no exact knowledge. Subsurface borehole caving was likened to surface erosion, but owing to the different character of these sediments and the greatly accelerated subsurface erosional forces, this parallel could not be drawn too far.

Present knowledge indicates three major reasons for differential hole size in a hole drilled with rotary tools: (1) action of the drilling fluid, (2) action of the bit, and (3) action of the drill pipe. Of these, it is believed that the action of the drilling fluid is most important.

The hole change caused by mud or any conventional drilling fluid is due either to a chemical effect (hydration) or a mechanical effect (attrition or dissolution). Of these two, it is believed that the former is the more important cause.

Water-base muds have a tendency to cause many shales to swell and heave or to disintegrate. Many shales disintegrate beyond the 32-in. range of the modern caliper tool. Interestingly enough, a mud cake may be built up on the face of a formation, causing a hole to caliper smaller than bit size.

In order to reduce hole change,

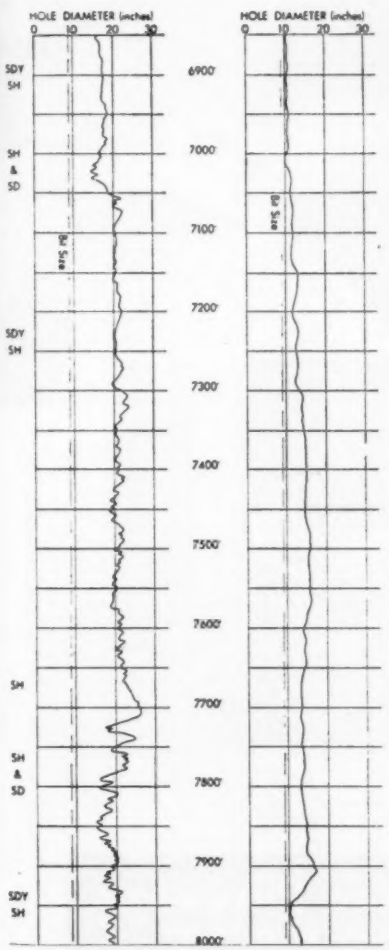

Fig. 1—Caliper logs of two wells in same field showing influence of mud on caving. (Water-base mud used in well to left and oil-base mud in the one to right.)

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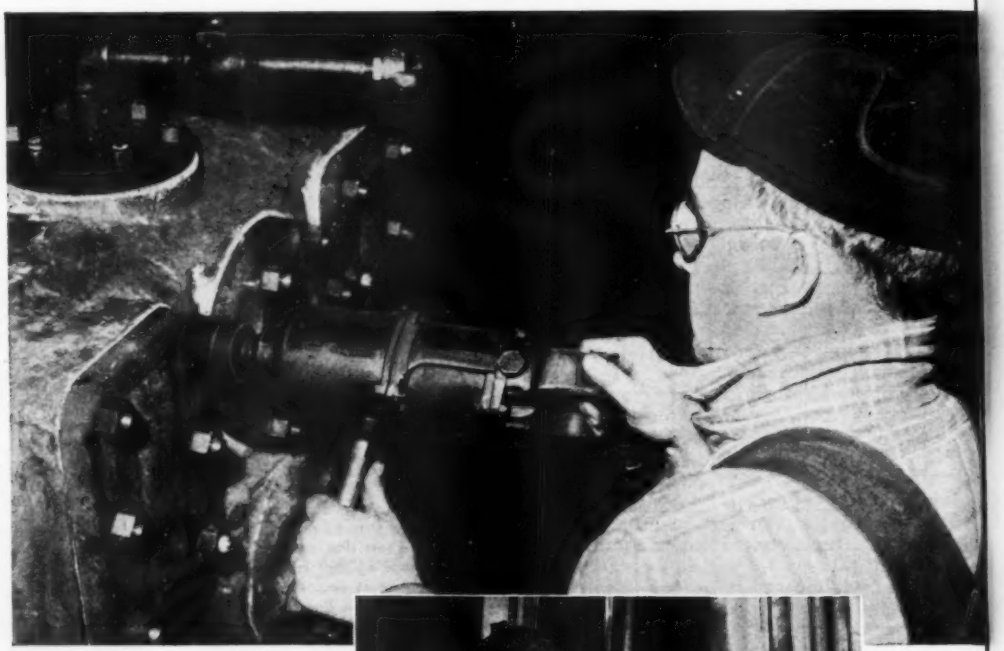

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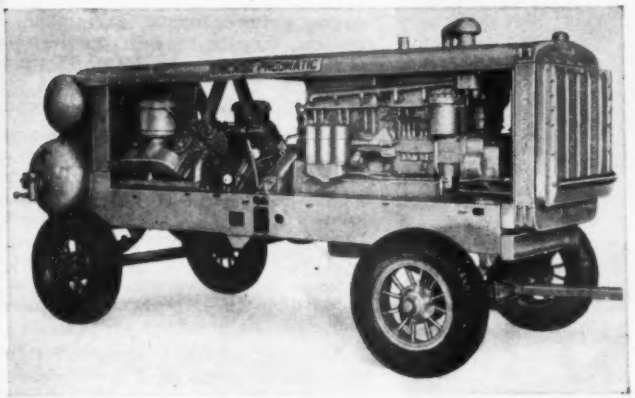

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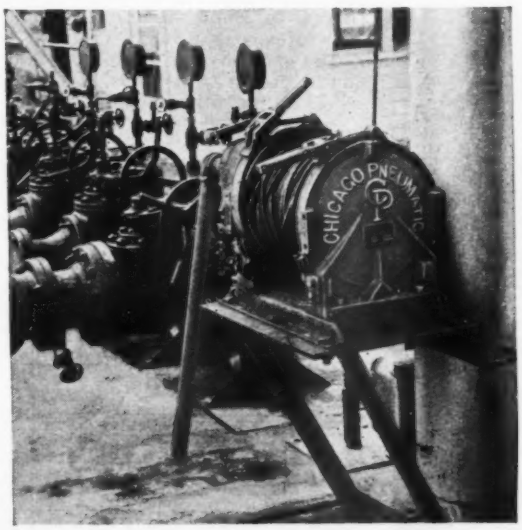
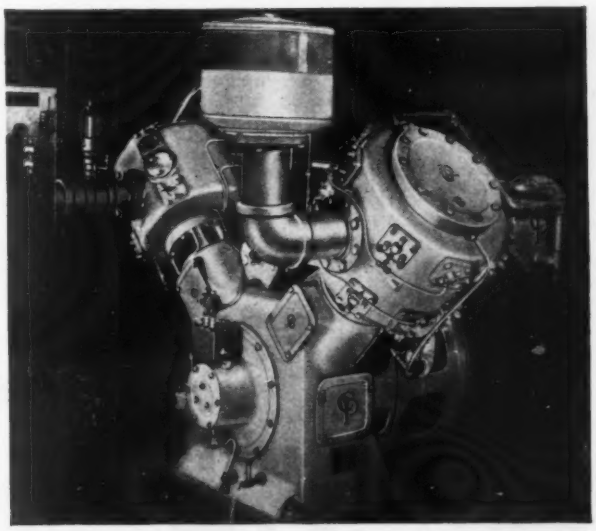


With the air-driven CP Utility Winch, control of all raising, lowering, holding and "teasing" operations is effected by means of the clutch and brake levers. Catheads, available for all models, increase versatility.



Type Y Compressors, ideal for close quarter installation, are shipped intact as "package units" ready for external connections.

many muds other than water-base muds are used. Oil-base, oil-emulsion, silicate-base, and salt-ba e muds are all commonly used to prevent the caving of shales or soluble formations. The effect of these muds on hole size has been clearly shown to the industry by caliper logs. Fig. 1 shows caliper logs on offset wells, one drilled with oil-base mud and one with water-base mud.

The present caliper is a chrome-plated tool 3 in. in diameter and approximately 5 ft. long. It consists of an oil-filled chamber containing the electrical components, the four caliper arms, and the releasing mechanism. The tool itself is standard equipment on an electrical-service truck and is run in a well on a ¼-in. logging line.

The four spring-actuated arms of the tool contact the walls of the bore hole when they are released. The motion of these arms is transmitted to a rheostat inside the oil-filled chamber by means of a flexible bronze cable-and-pulley system in such a manner that the change in resistance of the rheostat is always proportional to the change in average diameter as measured by the four arms. Owing to the spring tension in the arms, the tool will be approximately centered in the well, unless the hole is considerably off vertical.

The arms are held in a closed position by a steel band when going in the hole. This band can be broken at will, either by firing a brass projectile located underneath or by spudding on bottom.

The chamber of the tool is filled with oil and kept hydrostatically balanced by means of a large rubber diaphragm, which acts as a volume equalizer between the oil and the mud, compensating for the difference caused by the motion of the push rods and changes in temperature.

A constant direct current is supplied to the rheostat in the tool, and the resultant potential drop across it is measured and recorded as a caliper log. These logs take the form of a continuous galvanometer trace recorded on film showing the average diameter of the bore hole, recorded as a function of depth.

A study of numerous caliper logs soon leads one to the conclusion that caving patterns exist. Certain generalizations may be made as to the relative ability of rocks to stand up to bit size. These generalizations are shown in graphic form in the accompanying table.

ABILITY OF ROCKS TO STAND UP TO BIT SIZE

Rock—	Poor	Medium	Good
Sand		X	X
Shale	X		
Chalk			X
Limestone			X
Dolomite			X
Anhydrite			X
Salt	X		

Although similar drilling conditions and similar muds tend to standardize caliper logs, some astonishing long-range correlations may be made by using them, even for wells drilled under entirely different circumstances. In the West Texas area, a number of horizons may be recognized on caliper logs, from Upton County, Texas, to Hobbs field, Lea County, New Mexico, a distance of 120 miles.

The most obvious use for the caliper log in the oil industry is as a tool to calculate the proper amount of cement necessary to fill up the annular space

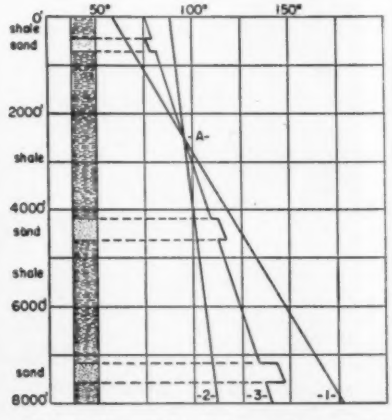


Fig. 2—Chart showing temperature gradients.

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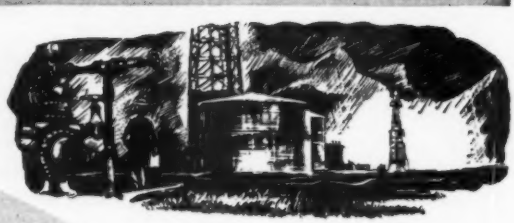

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between the casing and the open hole to a desired point. The actual amount of cement necessary for a desired fill is often two or three times the amount one would use from theoretical calculations.

Another problem encountered in the successful completion of an oil well is the location and reaming of tight spots in the hole, so that casing can be set and successfully cemented without channeling and bridging. The value of a caliper log in locating these zones has been demonstrated many times.

Modern drilling practices presuppose the use of many scratchers, centralizers, and guides welded to the casing to assist in obtaining a better cement job. All these tools have proved extremely useful in obtaining better cementing jobs and eliminating costly squeeze jobs, but they are useless unless properly positioned in the hole with the aid of a caliper log.

In plugging back with cement, plastics, or gravel packing, a knowledge of hole size is invaluable. In remedial work of this kind, well records are usually inaccurate or nonexistent, and it is only through an application of the knowledge gained from a caliper log that a successful job may be performed.

In the field of drill-stem testing, a knowledge of caving conditions has saved oil operators an untold amount of money. By applying the information to be gained from the use of a caliper log, the proper point to set the packer and the proper size of packer are easily determined.

Many other uses have been found for caliper logs. The successful completion of a fishing job may depend on a knowledge of the size of the hole above the junk. A log made after a fishing job is completed will provide the necessary data successfully to resume drilling operations.

A knowledge of hole size is essential in evaluating an acidizing job, picking a zone to side-wall core, evaluating the results of shooting with nitroglycerin, and finding a proper zone to gun-perforate. The present caliper log has fulfilled all these functions.

Temperature Logging

At the present time thermal measurements in either a cased or open hole are usually obtained by means of a continuous-recording, extremely accurate, electronic thermometer. Such a tool is standard equipment on an electric-logging truck and is run on a $\frac{7}{16}$-in. conductor cable.

The temperature electrode is a 3-in. rubber covered tool about 6 ft. long. In a groove in the rubber coating of the electrode is a 20-in. length of platinum wire, which is exposed to the mud column. This wire is small in diameter and assumes the temperature of the fluid around it rapidly. Changes in temperature produce changes in the resistance of the wire, which are detected by a bridge circuit in the electrode. Alternating current from a 500-cycle generator is supplied to the bridge terminals. The signal terminals of the bridge are transformer-coupled to the grid-cathode circuit of an a.c. amplifier circuit in the tool. The amplified a.c. signal is rectified and sent to the surface as a d.c. signal, where it is calibrated in degrees. In order to buck out the static value of this signal, a known matched signal of opposite polarity is placed in series with the electrode signal. The resultant d.c. signal is amplified in the instrument tray and recorded in the camera. A switch is provided in the tool for changing signal point at the a.c. bridge, so that the bridge can always be operated close to the balance point. This is necessary for two reasons, to reduce noise and to keep the electrode system from being saturated. The resultant log comes as a plot of temperature versus depth.

The standard electrode may be obtained in two temperature ranges, from 20° to 280° F. and from 60° to 340° F. Tools capable of being run in tubing are also made.

A fundamental knowledge of temperature gradients and temperature anomalies, as expressed in drilled

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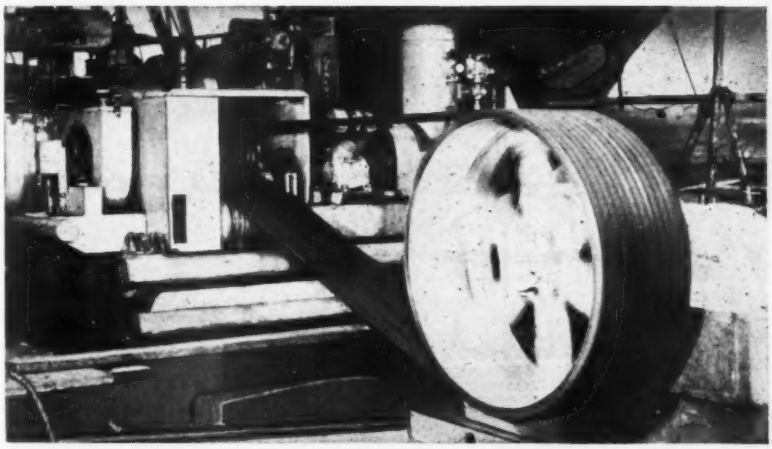

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holes, is necessary before the myriad uses of temperature logs can be fully realized.

Measurements made by a thermometer lowered in a drill hole give the temperature of the drilling fluid. Unless the hole has not been circulated for several weeks, the temperature of the mud is very different from that of the formations. The mud is usually colder at the bottom and hotter at the top of the hole than in the surrounding strata. Thus, when circulation is stopped, the mud will warm up in the lower part of the hole and cool at the top. The speed of this heat exchange will depend on the lithology of the bore hole.

To illustrate this, take a well 8,000 ft. deep, as illustrated in Fig. 2. The geothermal gradient can be represented by a straight line, as shown in Curve 1. The temperature of the mud, when circulation ceases, is almost the same from top to bottom, as indicated by Curve 2. The temperature gradients cross at Point A.

If the well is left idle for several days, the temperatures will tend to equalize and the mud curve will tend to rotate from 2 to 1 about the axis A.

The cooling or warming of the mud at a certain depth will depend on the thermal conductivity of the formations and the size of the hole. Experience has shown that equilibrium is reached sooner opposite sands than shales. This can be explained by the fact that (1) hole size is smaller opposite sands than shales, and, therefore, the volume of the mud is less, and (2) the thermal conductivity of sands is greater than that of shale.

Thus it will be seen that during thermal evolution, sands will exhibit a lesser temperature than adjacent shales in the top part of the hole and a higher temperature in the bottom part. Curve 3 of Fig. 2 represents the temperature of mud about 10 hours after circulation and illustrates this point.

If a temperature record is obtained immediately after circulation, a flat curve resembling Curve 2 of Fig. 2 will result. The same type of curve will be obtained after several days have passed and equilibrium has been reached. The most pronounced anomalies are obtained 24 to 36 hours after circulation has ceased.

Although from the foregoing discussion one can see that it is possible to distinguish sands from shales, the temperature log will not yet replace the electric log. Factors such as chemical reaction, changes in hole size, the movement of fluids between sands, and the movement of hydrocarbons can alter the temperature in a well.

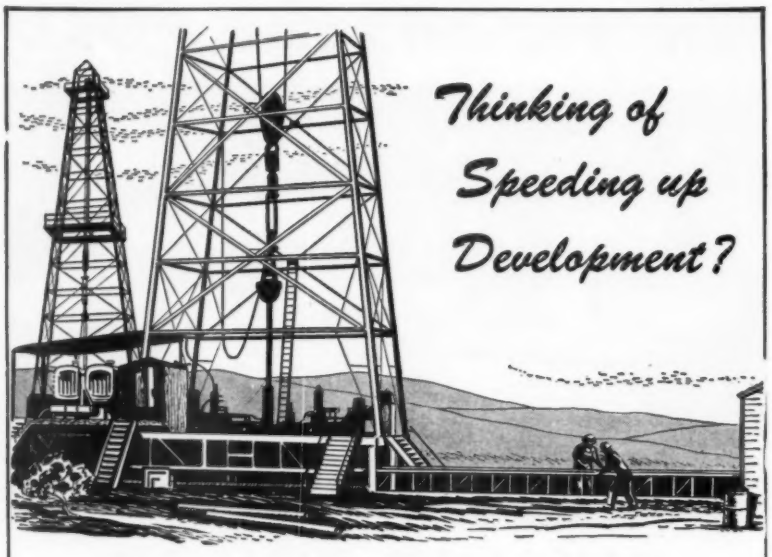
Thus far only open-hole-temperature measurements have been considered, but the presence of a string of casing does not disturb the thermic state of a bore hole. Therefore, all of this previous discussion applies to cased holes when they have been cemented, provided the temperature log is made 4 or 5 days after cementing.

Cement generates considerable heat as it sets up, and this factor has resulted in the principal application of temperature logs: The determination of a cement top behind casing by means of thermal measurements. The magnitude of this temperature increase varies with the time elapsed since cementing and the quantity of cement used.

Most of the heat is generated a few hours after the cement job has been completed. After this interval it is quite possible that the formation will absorb heat faster than it is generated by the setting cement, thereby cooling the mud. As a rule the best time to run a temperature survey is from 4 to 18 hours after the cementing plug has hit bottom. The exact interval depends on a number of factors. Most operators prefer not to release the pipe pressure until after the initial set of the cement, which is a function of the type of cement, the type of water, the temperature, the pressure, and other variables.

The quantity of cement also affects the magnitude of a temperature anomaly. The amount of deflection tends to vary as does the amount of cement, which is a function of hole size. The joint use of a caliper log when trying to interpret a temperature log is often useful in this respect.

Several precautions should be taken



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when obtaining temperature logs in a cased hole. Circulation after cementing has been completed results in the heat evolved by setting cement being dissipated, and a trustworthy record is not obtained.

Temperature surveys in their present form will tell how high cement is in the annular space and, comparatively, how much cement is behind pipe. However, the survey does not indicate where the cement is. It is, for all practical purposes, impossible to detect channeling on a cement job by means of a temperature survey.

Numerous other uses have been made of temperature records in both cased and uncased holes. As gas enters a well, either through a hole in the casing or into a bore hole on an uncased well, it expands and cools. This characteristic has been used to find oil-gas contacts or a hole in the casing. However, any use of a temperature log presupposes that the temperature anomalies being measured are of a greater magnitude than 4° or 5 °, these being the order of formation thermal differences.

Geophysical Activity In 1950

(Continued from page 107)

gravity effort over both hemispheres is illustrated in Fig. 4. In the preceding year the share of the United States was over one-half. In 1950 it fell somewhat below that proportion. The share of Canada decreased somewhat and that of Mexico rose. The combined effect of these changes was to reduce North America from 68.62 per cent in 1949 to 62.52 per cent.

There was an over-all decrease in South America, largely because of a reduction in Venezuela. On the other hand, the tempo of work in the Argentine and Brazil increased somewhat.

The most striking change in gravity operations occurred in the Eastern Hemisphere, which increased from 19.78 per cent of the total in 1949 to 26.88 per cent in 1950. The most active area was the Far East. Africa was second, more than doubling its percentage of the total. Europe was the only major sector of the Eastern Hemisphere in which gravity operations declined somewhat.

The distribution of the 1950 gravity operations within the United States is shown in Fig. 5. The State of Texas improved the commanding position held by it for some time by increasing its percentage from 34.81 per cent in the preceding year to 38.05 per cent in 1950. In Texas the trend was away from its coastal areas. Louisiana also improved its position slightly, but here the trend was toward greater emphasis of the coastal areas. The greatest relative change occurred in North Dakota, which more than doubled its percentage of the whole. There was some increase in California. The sector for "other states" is much larger in 1950 than it was the year before, indicating that a small amount of work was done in each of a larger number of states which in the aggregate made an appreciable contribution to the total.

Magnetometer Crew-Months

A total of 259 ground magnetometer crew-months was reported for 1950. Of this number, nearly one-half, 126, represent work done in North America. The Eastern Hemisphere accounted for 81 crew-months, more than two-thirds of this covering operations in the Middle East. South America accounted for 52 crew-months.

Statistics on airborne-magnetometer work remain spotty. Operations in the United States decidedly exceeded those elsewhere, but activity was reported from Africa, Europe, Canada, and Central and South America. While no measure of the magnitude of this work can be reported, it appears obvious that in terms of area covered, the volume of airborne work is greater than that done on the ground by a considerable factor.

If these statistics provided only a

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record of what has happened in the past, few of us would be interested in them. What really counts is: "What do they portend for the future?"

Manpower Problem

Our biggest problem in the immediate future is likely to be manpower. The effectiveness of geophysical exploration depends to a very large degree on sound technical training and on experience. The combined manpower pool of all geophysical operators is very limited, and there is a bleak prospect for any additions to it in the immediate future. It is more likely to shrink than expand. This will be no new experience since that is precisely what happened in the course of World War II. When we were in that position 10 years ago, we tried to make the manpower we had available stretch further by working it longer. We adopted extended work weeks and similar devices.

Geophysical field operations in normal times involve abnormally long working hours. Many operators have a normal 50-hour work week and most of them work regularly between 45 and 50 hours per 5-day week. During World War II many, if not most, operators changed to a 60-hour, 6-day week. Our experience with this was not satisfactory. The output per man was not increased proportionately, and there is reasonable doubt whether it was increased at all. In view of this experience, it is not reasonable to expect that capacity can be extended by working the personnel we now have for longer hours.

We will have other problems, of course, but the manpower problem towers above them all. If the geophysical activity the world over continues to increase, as it has in recent years, and American operators expect to retain the dominant position they have held for 25 years, this manpower problem must be solved. The maintenance of this position is not only of interest to the operators themselves. It is an asset to the entire economy which this country can ill afford to thoughtlessly surrender.

For the immediate future, the crystal ball seems to indicate a rising trend of geophysical operations in the United States as well as for the rest of the world. The demand is likely to exist and whether the potential expansion can be realized will depend largely on how well we succeed in conserving and expanding, if possible, our manpower to the level required.

Acknowledgment

The data on which this report is based have come from many sources, and any acknowledgment, here made, is small recompense for the interest and effort in assembling them. The capable and effective assistance of my colleagues on the Geophysical Activities Committee in providing primary data in readily usable form and the aid of my associates at Gulf in compiling the report are gratefully acknowledged.

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Digests

(Continued from page 132)

function of temperature is termed the "glow curve." This shows a series of light intensity maxima which depend on amount of radiation that the minerals have received, their impurity content, and their crystallization history.

The glow curves of the artificially induced thermoluminescence of many different limestones have been measured, and the shapes of these curves have been found to be characteristic of the particular limestone stratum from which the specimens were obtained.

Preliminary tests of the use of this property as a tool in surface correlation of limestones have shown it to be applicable under closely controlled sampling in thick limestones. It has also been found that certain well-known Pennsylvanian limestones can be differentiated over at least a county-wide area by the shapes of their glow curves.

Thermoluminescence as a Tool For Subsurface Correlation

JAMES M. PARKS, JR., University of Wisconsin, Madison.

CORRELATION by comparisons of thermoluminescent glow curves is possible with subsurface samples. Powdered samples are used instead of solid samples. As in surface correlations, carbonate rocks are the most suitable for thermoluminescent measurements.

The validity and usefulness of subsurface correlations by this method was tested on

the Chesteran limestones (Upper Mississippian) in the Illinois basin. Both surface samples and cable-tool well samples were used in this study.

The characteristic glow curves for each limestone were determined from surface samples from type areas. The eight Chesteran limestones were differentiated in the well cuttings by these characteristic glow curves. Correlation between wells was found to be possible by comparisons of series of glow curves from cuttings from each well.

Thermoluminescence as a Means For Relative Determination Of Limestones

EDWARD J. ZELLER, University of Wisconsin, Madison.

STUDIES of the thermoluminescent glow curves of limestones have suggested that the determination of relative geological age is possible. In general, the height of one of the glow-curve maxima will be proportional to the radiation received by the calcite lattice from the natural radioactive elements present during the geological time elapsed since the crystallization of the limestone. The relative or comparative age of two or more limestones is proportional to the comparative content of radioactive elements in each and to the comparative values for matching glow curve maxima.

The natural content of radioactive elements in each sample has been determined by means of a scintillation counter from which the relative values are obtained through direct comparison of the counting rates. Comparative values for matching peaks can be taken from the glow curves.

Corrections can be applied for any variations in rate of electron trap formation by long-term irradiations with gamma rays from Cobalt 60. A curve of the relationship between peak height and total gamma radiation received by a sample both from natural and artificial sources is plotted from data taken from long-term irradiations. The position of the natural sample can then be determined with regard to the glow-curve maxima. If the maximum has been exceeded, further radiation will decrease the height of the glow curve maxima. Determinations of absolute geologic age may be possible when sources of error in making absolute measurements have been reduced.

Ecological Control in Some Pennsylvanian Marine Invertebrate Faunas

L. M. CLINE, University of Wisconsin, Madison.

IT is well established that the composition of invertebrate faunas of the marine hemicycle of the simple Pennsylvanian cyclothem of the Eastern Interior and Western Interior coal basins varies vertically with respect to position in the cyclothem. The change from the meager fauna of the black shale immediately above the coal to the prolific fauna of the limestone in the middle of the hemicycle is a reflection of a gradual change from a brackish-water environment to the more normal marine environment which represents the high-water mark of each cycle of sedimentation.

In the more complex cyclothem of the upper Pennsylvanian, at least four types of marine limestones (the "lower," "middle," "upper," and "super" members) are recognized, and each lithologic type exhibits certain faunal characteristics that are independent of stratigraphic position. Regional stratigraphic work in the Desmoinesian series of the Western Interior basin, in which some of the Marmaton limestones have been traced several hundred miles along strike, has shown that the faunal composition of the limestone changes as one is traced from one facies to another.

To a certain extent the various facies faunas that are exhibited vertically in the simple cyclothem can be duplicated in a single marine horizon if that horizon is traced far enough to embrace several facies. There is a good correlation between the chemical composition of some limestones and their faunal content.

Frequency Analysis of Seismic Waves

J. J. JAKOSKY and JOHN J. JAKOSKY, JR., International Geophysics Co., Los Angeles.

FOUR years' laboratory and field work has been conducted in cooperation with a major oil company to determine the factors governing transmission of seismic wave energy through the earth. This paper describes phases of the work pertaining to frequency analysis of seismic waves and its application to seismology.

A discussion of the mechanism of seismic pulse generation is followed by discussion of factors governing changes in the spectral distribution of energy due to absorption, adsorption and scattering as the wave travels through the earth, the effects of low frequency cutoff, and variations in Δt by wave interference.

Examples are given from field work to illustrate changes in wave components under certain geologic conditions. The effects of air waves, surface waves, multiple reflections, and changes in spectral energy from shallow to deep reflections are shown after separating the various components by frequenecy analysis.

Illustrations and diagrams describe the equipment developed for this work. This instrumentation promises to be a powerful tool for seismic and geological research. By its use detailed studies may be made

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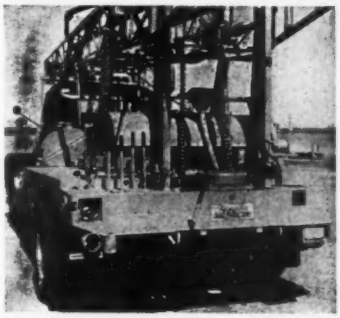

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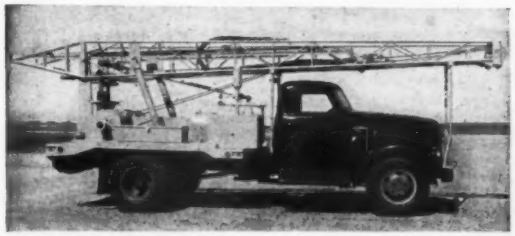

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Ground Roll Coupling to Atmospheric Compressional Waves

FRANK PRESS and MAURICE EWING, Columbia University, New York City.

A THEORETICAL treatment of ground roll originating from air shots and hole shots are given. In most regions Rawleigh wave velocities vary with period due to layering, being less than the speed of sound in air for short periods and exceeding this value for longer periods. It is shown that coupling of ground roll to compressional waves in the atmosphere exists for both air shots and hole shots in these regions. Experimental data obtained in the field are in excellent agreement with the theoretical results; namely, that the effective coupling exists for surface waves whose phase velocity is equal to the speed of sound in air.

It is also shown that body wave and surface wave character is almost independent of charge elevation in the range from 0 (on the ground) to 30 ft.

In a reciprocal manner ground roll from hole shots was recorded with air microphones as predicted by the theory.

Reflection Shooting on the Edwards Plateau

THOMAS C. POULTER and L. V. LOMBARDI, Standford Research Institute, Standford, Calif.

AN analysis is made of the energies which appear on seismic records obtained on the Edwards plateau, and such factors as multiple reflections, high frequency effects from superposition, and the jointed or "block" condition of the surface are evaluated.

As many as 60 multiple reflections are identified on a single record and means for almost completely eliminating them are described. The effect of superposition on the high frequency appearance of the records is illustrated. The use of multiple phones and mixing in overcoming some of the effects of the jointed or "block" condition of the surface is described, and the use of a pattern of small charges combined with the directivity thus obtained for improving the signal to noise ratio are described.

Some of the problems described and the general conclusions are based on an analysis of the records from more than 300 miles of survey in Crockett, Sutton, Pecos, and Schleicher counties.

Generation and Propagation Of Strain Waves in Rock

LEONARD OBERT, WILBUR I. DUVALL, and THOMAS C. ATCHISON, U. S. Bureau of Mines, Washington.

THE "near shot" generation and propagation of strain waves has been studied for shot sizes from 1 to 100 lb. First, strain gages and recording equipment were developed which could be employed in solid media (rock). Field studies were made in a number of rock types, and an empirical relationship between the shot size, distance, and strain developed. This relationship contains two constants which can be related to the rock type, explosive, and other experimental parameters, and these parameters can be compared through the evaluation of these constants.

The strain pulse resulting from the application of a steep-function pressure pulse to a spherical cavity in a solid medium has been calculated and compared with recorded strain pulses. Also, the resonance of a spherical cavity in a solid medium driven by a sinusoidal source has been calculated and the results compared with field data.

How Seismograph Interpretation Is Related to Changes in Sedimentary Section in West Texas and New Mexico

JOHN W. DALY and C. N. PAGE, Honolulu Oil Corp., Midland, Tex.

THE different rock types have characteristic seismic velocities. Within a given time-stratigraphic unit this may vary by as much as 300 per cent. Parts of regional velocity maps which demonstrate this fact are shown. The effects of these sharp velocity contracts on seismic interpretation are assessed.

Application of the Reflection Seismograph to Search for Stratigraphic Traps

W. E. PUGH and H. M. THRALLS, Seismic Service Corp., Tulsa.

REFLECTION seismograph surveys by the continuous profile method furnish opportunities for compilation of mass data. When these data are obtained and compared to detailed geologic information some time differentials are observed which cannot be ascribed to changes in depth of reflecting horizons. Analyses of these types of time differentials suggest an interpretative approach to outlining changes in stratigraphy. An example of the possibilities of such an analysis is cited—the interpretative technique applied to the South Ceres sand lens pool in Noble County, Oklahoma.

A revision in the over-all interpretative approach is needed if many stratigraphic-

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type oil traps are to be found with the seismograph. Important test wells should be seismologged as well as electrologged. Provisions should be made for more exact determination of interval velocities to provide for a study of internal velocity gradients as well as average velocity gradients.

Magnetic Well Logging

R. A. BRODING, C. W. ZIMMERMAN, E. S. WILHELM, A. A. STRIPLING, Magnolia Petroleum Co., Field Research Laboratories, Dallas.

NEED for control data in interpretation of surface magnetometer surveys has led to the development of bore-hole instruments for measuring magnetic susceptibility and total magnetic field in situ. The susceptibility instrument is an alternating current induction device and by separation of the quadrature components, simultaneous recording of the magnetic susceptibility and the electrical conductivity is possible. The susceptibility log has many features that depart from ordinary electric logs.

The instrument has a sensitivity of the order of $1x10^{-6}$ cgs units and sufficient contrast has been found in the sediments to yield a log of considerable lithologic character. This magnetic character suggests the use of the susceptibility tool in the field of special well logging, particularly for geologic correlation, and for tracer studies.

The general assumption that the magnetic susceptibility of the sediments is sufficiently low compared to basic igneous rocks and that sedimentary rocks have little effect on surface magnetometer measurements has been verified. Since the magnetic susceptibility and electrical conductivity logs are made with an induction instrument, an electrolyte is not required in the hole and the logs are independent of the drilling fluid, except that the conductivity log is influenced by highly conductive muds.

The total field log is made with a three element self-orientating saturable core magnetometer that has been developed for borehole use. This log has not been used extensively. In addition to reflecting changes in Polarization of the formations, it is influenced by formation susceptibility. Logs have been made of the total field going into and through igneous plugs.

The paper presents examples of these logs along with a brief description of the instruments developed to produce them.

World-Wide Gravity Program Of the Mapping and Charting Research Laboratory of the Ohio State University

W. HEISKANEN, Director, Finnish Geodetic Institute Director, Isostatic Institute of I.A.G. Consultant, Mapping, and Charting Research Laboratory of Ohio State University.

GRAVITY anomalies are an important tool in the hands of the exploration geophysicists. But they also have a very great geodetical significance. They enable us to determine the shape of the earth—the only method which, at least now, can do it. The gravity anomaly maps of the earth, which present, in broad lines, the gravity field of the world, enable us to compute the undulations of the geoid. We can also by means of these anomaly maps compute the absolute deflections of the vertical at any point, in the vicinity of which local gravity survey exists—at least about 100 stations inside the circle of 200 km. radius. By means of these absolute deflections of the vertical we can convert the astronomical positions to the geodetic ones.

We have in the Mapping and Charting Research Laboratory in Columbus planned a world-wide gravity program by the aid of which we can obtain the following aims:

1. To determine a general world geodetic system and to convert the geodetic systems, (North American, European, Russian and so on) to this system.

2. To be able to compute, on the world geodetic system, the geographical coordinates of any important point in the world where astronomical observations exist or which is plotted on a local map with a reliable grid.

3. To be able to compute the distances and directions between any required points in the world.

4. To control the maps on scale 1:100,000 and on smaller scales.

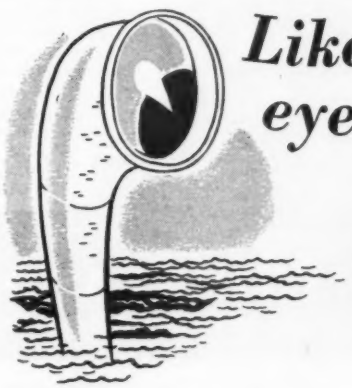
5. To study the size and shape of the earth's ellipsoid and geoid.

About 3,000 new gravity stations, evenly distributed, and many local gravity surveys and, of course, an enormous amount of analyzing work are needed. Many leading scientists and some universities have already promised a close cooperation. We hope to get much valuable help from the side of the prospecting geophysicists.

Regionals, Residuals, And Structures

L. L. NETTLETON, Gravity Meter Exploration Co., Houston.

SINCE the earliest applications of gravity and magnetic methods, interpreters have recognized the problem of separating local from regional effects. Residual anomalies have been determined by simple inspection, by smoothing contours, by profiles and by a variety of numerical schemes including the calculation of higher derivatives. The possibilities and limitations of the various methods are illustrated by examples. It is pointed out that the inherent ambiguity of the interpretation of potential fields precludes the general and automatic application of any single scheme of isolation of anomalies. The selection of significant anomalies is not an exact science but is largely an art, dependent on experience



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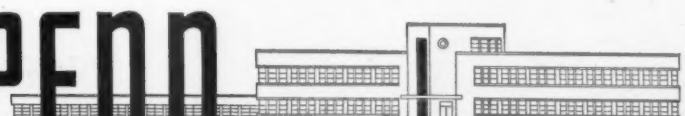

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Regional Gravity Survey in Northeastern Oklahoma and Southeastern Kansas

KENNETH L. COOK, U. S. Geological Survey, Salt Lake City.

IN 1948 the Geophysics Branch of the U. S. Geological Survey, in cooperation with the U.S. Coast and Geodetic Survey, made a regional gravity survey in northeastern Oklahoma and southeastern Kansas. In Oklahoma about 370 gravity stations, located at points forming approximately rectangular patterns with 5 to 10-mile spacings between individual stations, were taken in parts of 30 counties. In Kansas about 180 stations, located similarly with about 10-mile spacings between individual stations, were taken in parts of 24 counties.

The gravity data, which were obtained with a Frost gravimeter, were reduced by conventional methods to give simple Bouguer gravity values of the surveyed area. A Bouguer gravity anomaly map, contoured at intervals of 5 milligals, is presented and discussed. In most of the surveyed area the pre-Cambrian basement complex lies within a few thousand feet of the surface of the earth. The observed Bouguer gravity anomalies are apparently caused largely by variations in either the composition of the pre-Cambrian basement complex or the present topography of the pre-Cambrian surface, or a combination of these two factors. (Published by permission of the director, U.S.G.S.).

Seismic Velocity as a Function Of Depth and Geologic Time

L. Y. FAUST, Amerada Petroleum Corp., Tulsa.

VELOCITY of longitudinal seismic waves as a function of depth of overburden and of geologic age was studied in more than 500 velocity surveys. Except for a brief reference to limestone velocities the paper is concerned with velocities in sections of sand and shale. Averaged interval velocities of shale and sand sections are presented graphically arranged by depth and age. The effect of lithologic variations is discussed.

A formulation of the quantitative relationship between the variables is attempted in the latter portion of the paper. It is concluded that velocity in feet per second for an average shale and sand section at a depth of Z feet and of age T years is given by: $V = 125.3\ (TZ)^{1/6}$.

Discussion of Seismic Reflection Quality Map of The United States

PAUL L. LYONS, Carter Oil Co., Tulsa.

A REFLECTION quality map of the United States has been prepared by a subcommittee of the program and arrangements committee of the S.E.G. The map designates as good, fair, poor, or "NG" all sedimentary areas where sufficient knowledge from conventional seismic operations is available. The map may be used in the planning of geophysical operations. Reflection quality is a function of many geological factors.

Delineation of Sedimentary Basins By Means of Magnetics

JAMES AFFLECK, Gulf Research & Development Co., Pittsburgh.

CALCULATION from various types of magnetic anomalies of depths to magnetic basement yields useful information for the delineation of sedimentary basins. A number of typical anomalies are shown on slides, and the results of depth calculations are discussed, together with the inherent limitations of the method.

Interpretation of Neutron and Gamma-Ray Well Logs

WILLIAM L. RUSSELL, Texas A. & M. College, College Station.

THE recent improvements in the methods of making and interpreting natural gamma-ray and neutron well logs are discussed. The first step in establishing the interpretation consists in determining how the various factors are expressed under normal conditions. The effects of unusual conditions and the exceptions to the general rules of interpretation are also considered. Other topics described are the accuracy, errors, and limitations of natural gamma-ray and neutron well logs, their uses and advantages, and the problems on which further research is needed.

Genesis of Reservoir Rocks

GORDON RITTENHOUSE, University of Cincinnati.

MANY characteristics of oil and gas reservoirs appear to have little "rhyme or reason." The writer believes that such reservoirs are not erratic in their behavior or occurrence, but owe their characteristics to a combination of events that have followed definite physical and chemical laws. Insufficient data, knowledge, or interpretation cause the trouble. The purpose of this paper is to discuss the genesis of reservoir rocks and the ways in which knowledge of genesis can be applied. Particular emphasis is given to reservoirs in which the porosity is primary.

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A better understanding of the lateral and vertical variations in porosity and permeability is one of the most important contributions that genetic studies can make. In most sandstone and many clastic carbonate reservoirs, porosity is present at the time of accumulation and is increased or decreased by postdepositional changes. Recognition of the type of "sand" body immediately suggests basis patterns of lateral and vertical variation within the reservoir.

After deposition, the porosity may be modified by readjustment and fracturing of grains, filling of the pores with cement, differential removal by solution, solution at points of contact between grains and deposition in the adjacent pores, plastic deformation of the grains, replacement, and recrystallization. Which of these processes have occurred, their relative importance, and particularly the time of occurrence appears to be significant in understanding porosity variations in reservoirs.

The relation of reservoir rocks to (1) the fluids that have passed through them, remain in them, or may be introduced, and (2) the changes that result from reduction in pressure and from depletion appears to be closely related to the composition and history of the reservoir.

Specific Reservoir Concept In Oil Finding

PAUL D. KRYNINE, Pennsylvania State College.

CAREFUL comparative studies suggest that within oil regions and even within individual oil fields there is a consistent relative petrographic difference between oil-bearing and barren (or only water-bearing) rocks. This is true even in the case of apparently uniform porous sandstones that may change from oil bearing to water bearing within one field. These differences may or may not be associated with the configuration of the "conventional trap." If not associated, the petrographic factors that produce a specific reservoir control the large-scale oil-accumulation pattern. These petrographic differences are due to variations in pore pattern and can be translated step by step into petrographic textural and compositional makeup, into field lithology, and finally into so-called "structure." The so-called trap may only be a reflection of these basic differences.

Significance of Evaporites in Depositional Sequence

L. L. SLOSS, Northwestern University, Evanston, Ill.

NUMEROUS authorities have contributed to an understanding of the physicochemical conditions responsible for the accumulation of evaporites and this understanding is being constantly refined. Paleoecologic interpretation of evaporites, however, is made difficult by the unfossiliferous nature of evaporites and their vertical and lateral association with fossiliferous strata without marked intergradations. Nevertheless, the physical evidences of environment, coupled with such biologic data as are available, and considered jointly with the apparent tectonic behavior of depositional sites, make possible the drawing of certain generalizations with respect to the significance of evaporites.

Analysis of the geographic distribution of evaporites and their occurrence in the stratigraphic column indicates that they may be formed under a wide variety of environmental and tectonic conditions. Of these, the marine neritic environment associated with active intracratonic basins appears to be responsible for the greatest volume of evaporitic accumulations.

Vertical relationships of evaporites to other sediments in a depositional sequence are more easily observed than lateral relationships. The position of evaporites may be considered in general terms and in detail. Typical gross relationships include a thick normal marine succession at the base, multiple evaporites, and a thinner interval of nonevaporitic deposits closed by a disconformity or break in deposition, with a covering of stable shelf sediments.

In detail, most basin evaporite successions exhibit cyclical successions of normal marine, nonevaporitic unfossiliferous sediments, and evaporites, with considerable variation in the dominance of particular elements at different positions in the depositional basin.

Evaporites may be traced laterally and shown to be limited geographically by a number of peripheral or bounding conditions including: nonmarine or littoral clastics, unfossiliferous dolomites, fossiliferous limestones, oolites, and reef or reef-flank materials. These associations, when occupied with tectonic and geographic considerations, lead to a tentative genetic classification of basin evaporites into categories defined by: (1) Nonbiologic control, (a) tectonic control alone(?), (b) topographic control; (2) biologic control, (a) back reef, (b) reef enclosed; (3) combination of controls.

Porosity-Profile Determination From Electric Logs

T. R. WRIGHT and S. J. PIRSON, Stanolind Oil & Gas Co., Tulsa.

NARROW-SPACED resistivity-measuring systems used in electric logging of wells respond mostly to the resistivities of the mud in the well bore and of the mud filtrate invaded zone. After the necessary corrections are made for hole size, electrode spacing, and mud resistivity, one obtains the true resistivity of the invaded zone. The latter is a function of mud resistivity and of its characteristics as well as of the porosity of the formation and of other lithological factors such as the cementation and saturation exponents.

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These exponent values are reasonably characteristic of well-defined reservoir rocks. If reasonable assumptions are made on the resistivity of connate water, the degree of its flushing by mud filtrate invasion, and on residual oil and/or gas, porosity may be calculated at various levels in the well bore.

Limitations must necessarily be imposed on the approach since the presently accepted mathematical petrophysical expressions apply only to intergranular porosity.

An application of the approach to the interpretation of the limestone sonde (LS32″) illustrates the method.

Photogeologic Study in Kent County, Texas

CHARLES DEBLIEUX, Consultant, New Orleans, La.; G. F. SHEPHERD, geologist, General American Oil Co. of Texas.

PHOTOGEOLOGY is an important and successful technique in West Texas exploration. Reflections of structure in Permian beds are shown to persist through the Cretaceous and Triassic mantle and are evident on the surface. A review of an actual photogeologic study of western Kent County is presented and substantiated by a critical evaluation in subsequent exploratory drilling.

Photogeologic anomalies are identified by occurrence of tonal and textural bands which outline areas of abnormal surface conditions. The tone of these bands is expression of subtle soil and moisture content differences. Surface texture is a product of sheet erosion and textural contrasts are the result of small relief differential. Application of these criteria is demonstrated in Scurry County structures and amplified by the illustration and description of six anomalies in Kent County.

A drilling program was initiated by General American Oil Co. of Texas to test four of these photogeologic anomalies. The first well penetrated a thin basal Canyon Reef section below water level, but encountered oil and gas shows in the Strawn. This evidence of accumulation confirmed the presence of a structural anomaly, but oil was not present in commercial quantities. The second was completed as a discovery well in the Strawn.

A drill-stem test in the lower Strawn section of the third well flowed pipe-line oil at the rate of 21 bbl. per hour and at the end of 5½ hours flowed 95 per cent salt water. Although this well was finally abandoned it also confirmed the anomaly. The fourth well was a dry hole with no shows and further drilling is required to prove the presence or absence of structure corresponding with the photogeologic anomaly. On the remaining two photogeologic anomalies other operators drilled a Strawn discovery well and a major extension to a Canyon reef field. Thus, in the exploration of six photogeologic anomalies, five confirmed corresponding structural anomalies.

Microscopic Studies of Capillary Flow, a Film

Division of Petroleum and Natural Gas Engineering, Pennsylvania State College.

THE film is a contribution from the Petroleum Production Research Laboratories of the Mineral Industries Experiment Station, Pennsylvania State College. The project under which the film was made was sponsored by South Penn Oil Co. of Bradford, Pa. The project was undertaken in an attempt to visualize some of the actions and interactions between fluids which were occurring in porous materials.

It is believed that such visual examination would aid in interpretation of other experimental work.

The significance of the film lies in opening the way for the use of this type of approach to petroleum research. The content of the film includes a discussion of the technique, both mechanical and photographic, with action shown of the displacement of oil by water and water by gas. The majority of experiments were made in a tubular capillary, at first being filled only with two fluids and later being filled with particles of quartz. Later action in the film shows displacement of oil by water in a thin section of sand grains.

Resistivity of Brine-Saturated Sands in Relation to Pore Geometry

W. O. WINSAUER, H. M. SHEARIN, JR., P. H. MASSON, and MILTON WILLIAMS, Humble Oil & Refining Co., Houston.

A METHOD has been devised for the direct determination of the tortuosity of pore channels in porous rock. The tortuosity, a geometrical parameter, together with the porosity, determines the resistivity factor. Experimental determinations made on a suite of sandstone samples selected to cover a wide range of texture have shown that (1) tortuosity values were lower than had been previously supposed, (2) the resistivity factor is related to porosity and tortuosity, (3) the resistivity factor is correlative with the packing index, and (4) the resistivity factor can be approximated by means of a relation involving only resistivity factor and porosity.

D'Arcy's Law

M. KING HUBBERT, associate director, Exploration and Production Research Division, Shell Oil Co., Houston.

MATERIALS of the outer part of the earth consist of solids — the familiar rocks and minerals—and of the fluids, prin-

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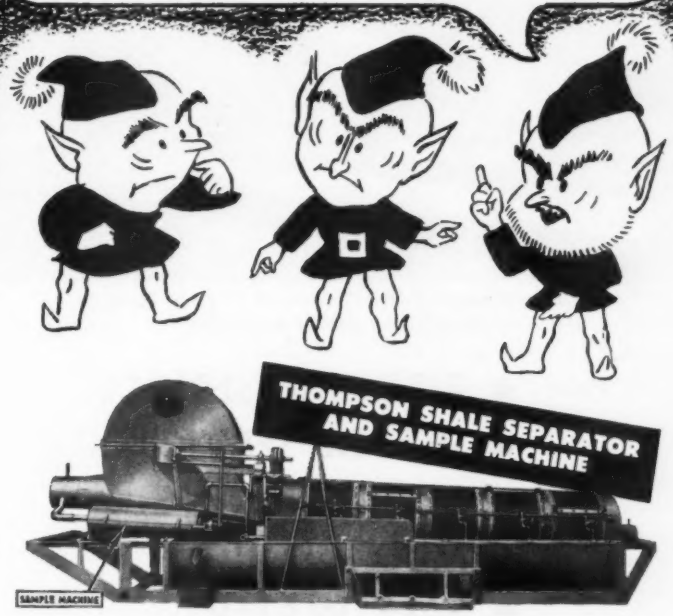

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cipally water, which completely fill their pore spaces. The solids have long been the subject of intensive geological investigation, but the comparably important fluids have been relatively neglected. The object of the present paper is to attempt to alleviate in some measure this neglect by presenting some of the fundamental principles upon which the motion of single-phase fluids underground depends.

The pore spaces of the rocks comprise an interconnected three-dimensional network of fluid-filled channels giving to the contained fluid a freedom of motion in three dimensions. Viewing such a system macroscopically we have in effect a fluid-filled continuum with an apparent fluid density proportional to the porosity of the rocks. Since the motion of the fluid in such a space is not directly observable, our ideas of what motions should occur under given conditions are necessarily inferences. We are confronted, therefore, with the problem of what are the conditions such an inference must satisfy in order to be valid.

Fundamentally these are three: (1) Out of all states of motion which a fluid in a given space might be supposed to have, only those are possible which do not require the creation or annihilation of matter; (2) Out of all states of motion satisfying the conservation of matter, only those are possible which do not also constitute perpetual-motion mechanisms; (3) For conditions which normally prevail underground, out of all imaginable states of motion satisfying conditions 1 and 2 above, only those are possible which also are in agreement with the requirements of D'Arcy's law.

For a given set of initial and boundary conditions and fluid properties, the number of flow patterns satisfying simultaneously all three of the foregoing requirements reduces to but one, and the solution is unique. All other supposed flow patterns are impossible.

It is proposed to elaborate these points with particular attention to the historical development and physical significance of D'Arcy's law, and also to show their application to a variety of systems of flow.

Interstitial Water in Petroleum Reservoirs

W. A. BRUCE, Carter Oil Co., Tulsa.

FACTUAL information from oil-base cores showing the presence and distribution of interstitial water in petroleum reservoirs is presented and discussed. The capillary retention properties of porous reservoir rocks are described and discussed in terms of the capillary retention theory. The capillary pressure curves and capillary character of rocks of different lithologic type are compared with the visible textural characteristics shown in thin sections.

The importance of fine-grained material in controlling capillary character, hence interstitial water, is brought out. Logic of the "restored state" concept is presented and laboratory tests based on it are described. Proof of the validity of the restored state test for interstitial water is reported from printed reports and tests not previously published.

Measurement of Grain Packing in Sandstone

PETER H. MASSON, Humble Oil & Refining Co., Houston.

A METHOD by which the degree of grain packing in sandstones can be evaluated from thin sections has been devised and tested. In straight traverses across the section one contact in each grain is classified, as it is intersected by the center of the ocular cross-hair, into one of two categories. Contacts are either grain-to-grain, or grain-to-matrix (or void) in nature, and the percentage of total contacts counted which are of the first type is taken as the packing index for the sample. Packing indices thus derived are purely empirical, but they vary through a six-fold range so that different sands can be distinctly characterized. Reliability of the packing index as a measure of the true state of compaction in sands was tested by comparison with direct measurements of pore volume and configuration in the same samples.

Classification of Carbonate Reservoir Rocks and Petrophysical Considerations

G. E. ARCHIE, Shell Oil Co., Houston.

RECENT limestone development at increasingly greater depths with accompanying higher per well cost has made the problem of determining net pay thickness of limestone reservoirs more exacting. In discussing the petrophysics of limestones, it is necessary first to classify them in a manner to portray as much as possible the essential pore characteristics of a reservoir.

A skeleton classification with symbols is presented and coordinated with petrophysical data, such as porosity, permeability, capillary pressure, and electrical resistivity of water-bearing and oil-bearing limestones.

Petrophysical relationships or trends of limestone are presented; however, the application of these relationships to field practice is much more difficult than for sandstones because of the great amount of dense limestone generally found in the reservoir. This increases the so-called "geometrical" variables, making well-logging interpretation difficult.

It is shown that the productive part of a limestone formation may be indicated by increases (or, in some cases, no variation at all) in the resistivity, depending mainly on the variation of porosity (or permeability) with water saturation, i.e., pore-size distribution.

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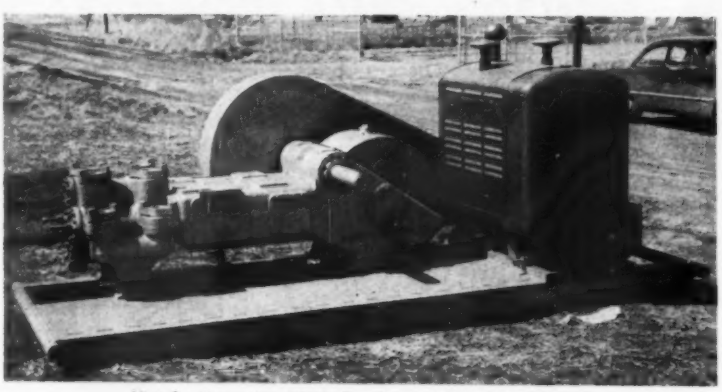

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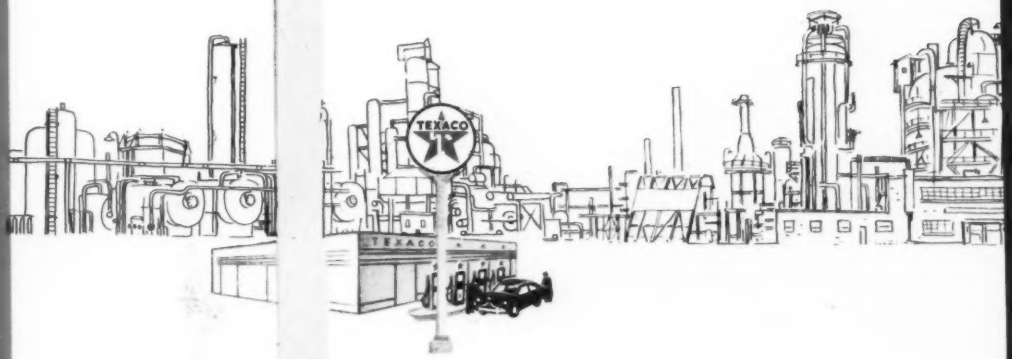

Seven Mighty Crackers...for Texaco!

When The Texas Company built its first Fluid catalytic cracking unit back in 1942, Kellogg did the job. Since that time, Kellogg has erected seven additional crackers for Texas refineries in New Jersey, Illinois, Oklahoma, Wyoming, Texas and California.

Historically, Kellogg undertook its first job for Texaco back in 1929... a thermal cracker at Amarillo, Texas. During World War II, Kellogg designed a Hydroforming unit for the production of high octane components for aviation gasoline. Built at Lockport, Illinois, it was the forerunner of Texaco's vast post-war modernization and expansion program.

Within the past year, Kellogg has completed thermal reforming and catalytic polymerization facilities, as well as a catalytic cracker at Texaco's new refinery, Eagle Point Works, at Westville, New Jersey.

THE M. W. KELLOGG COMPANY

A SUBSIDIARY OF PULLMAN INCORPORATED

for fifty years an integral part of processing history

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KELLOGG
1901 1951

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Portrait at

This year is Kellogg's fiftieth of service to industry. At this time naturally, as a group of men—known collectively to the modern business world as The M. W. Kellogg Company—we can think back nostalgically. We can remember the chimney stacks

"Against Tomorrow's Conditions"

The first two of these camera "portraits" of M. W. Kellogg today which have already appeared in this publication, high-lighted the major aspects of the chemical, metallurgical and process research carried on by the Kellogg organization.

This month, a few of the continuing development projects based on this research are described —with indications of their importance in the advancement of processing, engineering and fabrication.

1. *WHILE THE PRIMARY ACTIVITY* of the Metallurgical Engineering group is concerned with the everyday problems of Kellogg operations, these facilities have also been utilized in connection with national defense. Because of their knowledge of metals and heat exchange, the services of these men have been required in the design of rockets and jet turbines. Here you see the engineering personnel assigned to this task.

4. *IN GAS AND ELECTRIC FURNACES* such as this, metals are subjected to temperatures approaching those of rocket engines in operation . . . and useful data from post-heat conditions of the materials can then be derived. Evidence of the success of Kellogg's work in these fields is seen in the fact that this development group has recently perfected a new method of heat exchange jacketing for combustion chambers.

5. *KNOWLEDGE OF THE MECHANISM* of combustion of various fuels is as essential to the design of familiar process furnaces as it is to special combustion chambers. Here you see a test chamber for rocket and jet fuel study. In the future, such studies will stand industry in good stead as process plants are required to produce special jet and rocket fuels in quantity.

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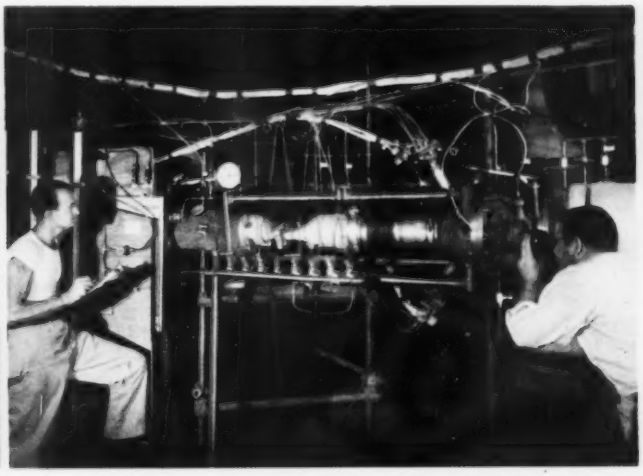
Fifty... no. 3

M KELLOGG W
1901-1951
50th Anniversary

we built in 1901 . . . the first crude vessels for oil refiners in the 'teens . . . our first combination unit. The forty-odd Fluid cat crackers built in these years. But, after all, The M. W. Kellogg Company is only a factor as it is able to serve industry today. For that reason, we are presenting this series of monthly camera studies which document our belief that a truly integrated organization can better serve industry to achieve greater earning power. This is No. 3 in the series.

2. *AT FIRST GLANCE* these specialized projects may appear far removed from the direct interest of the oil refiner. But the facts are just the reverse. The solution of rocket and jet turbine design problems opens new ranges of operating temperatures, new types of heat exchange equipment and tremendously improved turbines and pumps. Modern dynamometers are employed in studies of various types of turbines and pumps.



3. *IN THIS MINIATURE TEMPERATURE CHAMBER,* stratospheric frigidity can be created outside of a piece of equipment while it operates at super temperatures inside, or vice versa. This is a modern counterpart of the development which Kellogg instituted more than twenty years ago, when it began investigating the effect of low temperatures on metals in connection with propane lubricating oil processes.

6. *AN IMPORTANT PHASE* of the study of fuels is the observation and recording of the act of combustion itself—which is carried out by this apparatus—by means of high-speed color photography of flame characteristics and fuel burning. Other facilities include stands and firing pits for the testing of completed prototype rocket motors. The group has designed and built rocket motors with thrusts up to 30,000 lbs.

7. *THESE ELECTRONIC SIMULATORS* are indicative of the equipment placed at the disposal of the company's development men. Similar in purpose to the giant electronic calculating machines, they provide shortcut answers to design problems requiring extensive time-consuming mathematical calculation.

NEXT MONTH

. . . in the fourth in this series of camera studies of M. W. Kellogg today . . . you will see how Kellogg channels the results of development into a specific industrial project.

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Process Piping
Hi-pressure—Hi-temp Power Piping
Bends and Headers
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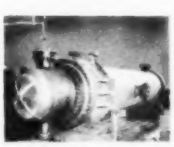
Forged and Welded Fittings
Radial Brick Chimneys

Continuing Basic Study of heat exchange by Kellogg development groups over 20 years has produced unduplicated design data.

Shop Layout Craftsmen have had experience on all types of heat exchangers, from marine condensers to jet engine combustion-chambers.



Rigid Quality Control is maintained by inspectors reporting directly to *Shop Management* rather than to *Production* executives.

Extensive Shop Facilities, from plate bending to stud threading, permit *complete* fabrication of any type heat exchanger.

Special Shop Techniques—the component parts of each exchanger are fabricated as a production unit, building in the advantages of "tailor-made" fit.

NEWS FOR OPERATORS IN WESTERN CANADA!

The Canadian Kellogg Company Ltd. has established complete shop facilities for the fabrication of all types of piping at **EDMONTON**, Alberta. Inquire directly or through any Kellogg or Canadian Kellogg office.

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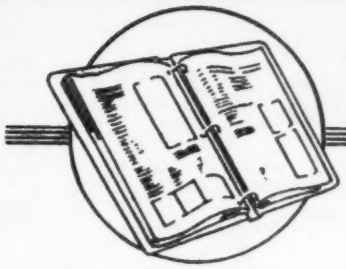


THE REFINER'S notebook

No. 68

Additives and Other Factors That Influence Grease Characteristics*

CHEMICAL and physical properties of petroleum oils used in the manufacture of greases and their effect on grease behavior was dealt with in the preceding installment. Effect of the kind of metal atom in the soap fat or fatty acid used, and water and glycerin in the grease have also been noted. Other factors that influence grease properties are: (1) chemical additives used and (2) percentage of soap employed.

Chemical Additives

Added chemicals or additives may be used to alter or enhance grease characteristics. Perhaps 90 per cent of the greases manufactured today contain only a metallic soap, petroleum oil, glycerin as a byproduct of saponification, and perhaps water. However, the small percentage of specialized greases containing additives is becoming increasingly important.

There are five predominant types of additive materials. Their purposes are: (1) to govern consistency, (2) to improve resistance to heat, (3) to improve resistance to oxidation, (4) to impart "extreme pressure" characteristics, and (5) to improve rust-preventive qualities.

Consistency of the grease can be changed. Additives may be used to reduce the tendency of a grease to soften when worked. Such additives improve the mechanical stability of the grease, probably by strengthening the soap lattice structure.

Resistance to heat may be improved. An example is the use of additives to improve the heat stability of certain lime-soap greases. Normally, lime-base greases break down at temperatures in the neighborhood of 160° F. By the use of suitable additives, certain improved lime-base greases can be heated repeatedly above their melting point (170°-200° F.) and above the boiling point of water (212° F.) without breakdown.

*From material prepared by Shell Oil Co. on "Fundamentals of Lubricating Greases."

Oxidation stability goes hand in hand with heat stability. Oxidation of either the soap or the oil in a grease creates serious problems of grease deterioration, since even small amounts of oxidation products will cause rapid breakdown of the grease structure. Oxidation inhibitors have been used to prepare greases that show manifold resistance to oxidation. Such additives are especially important in greases for sealed bearings and those used on mechanical parts that may be destined for long-time storage.

Extreme-pressure properties may be imparted by additives. Ordinarily, greases may be said to have "mild extreme - pressure" properties. However, they may be subjected to high shock loads or heavy overloading, or to conditions of extreme pressure and in such cases require additives to prevent damage to the bearing parts. The usual additives for this purpose are sulfur, sulfurized oils, chlorinated compounds, lead soaps, etc. Relatively small percentages of the additive are sufficient in many applications.

Rust-preventive qualities in the grease are sometimes important under certain severe conditions of operation or storage. Considerable progress has been made in the use of additives in this connection. Some of the sulfonates, lead soaps, emulsifiers, and other materials developed for this purpose are of particular interest to research men. Many of the military specifications call for rust-resistant qualities in greases because of the severe conditions of storage and operation.

Percentage of Soap Used

The percentage of soap used in a grease is of importance primarily because this factor, within certain limits, is one of the most important of those governing the consistency—the "stiffness" or "hardness"—of the finished grease. Since consistency is the characteristic of greases generally considered primary in the marketing and use sense, this term needs further clarification. Briefly stated, the consistency of a grease is measured by a physical test called the penetration test. The sample of grease is brought to a definite temperature (77° F.) and the depth to which a special standard cone-shaped device penetrates it when dropped on the sample is measured. Marketwise, the grease is then rated as to its consistency according to a standard table of penetrations.

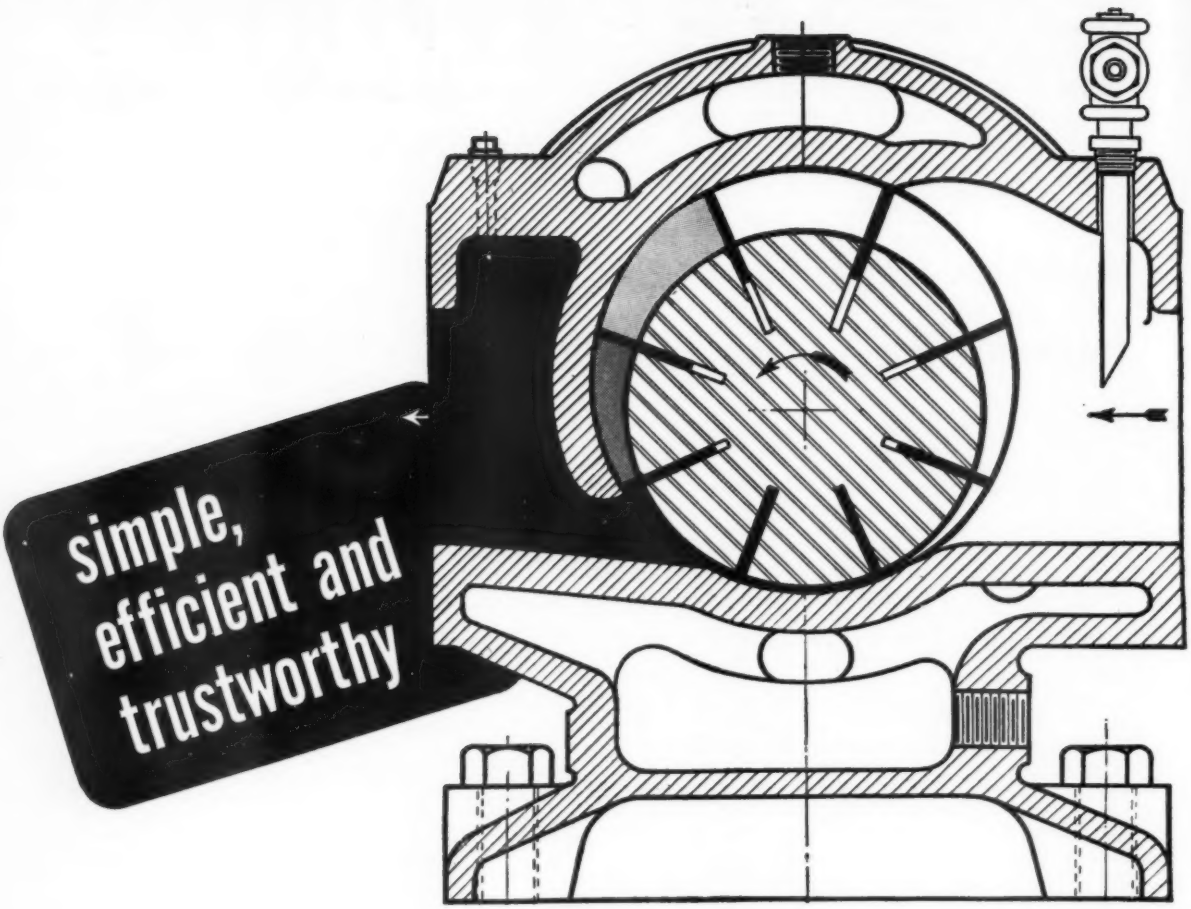
Actually, this test does not tell anything fundamental about a sample of grease and is of importance only in classifying the grease for marketing and in manufacturing control.

However, amount of soap used in a given grease will help to determine its consistency. In general, the more of a given soap used, the stiffer or harder will be the consistency of the products. What we commonly think of as a "typical" grease consistency is a mixture containing about 10 per cent soap. The proportion of soap to oil in a grease seldom exceeds 25 per cent except in the case of "brick" greases where the soap content may be as high as 50 per cent.

In this connection, another point to be remembered is that the type of metallic atom in the soap also enters into the consistency picture. That is, a grease made with 10 per cent of one type of soap and a given petroleum oil will have a certain consistency, while if 10 per cent of another type of soap is used with the same petroleum oil the resulting grease may be either softer or harder, depending on the types of soap used.

Manufacturing Techniques

Another item that requires discussion is the influence of manufacturing techniques on grease characteristics. Since this series on greases is not intended as a greasemaker's handbook, only a brief summary of some of the high points in the processes used will be given. Some of the more important grease tests will also be summarized. These include the tests for penetration, dropping point, apparent viscosity, shell-roll stability and oxidation stability.



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The Fuller Rotary Compressor assures a smooth flow, with no pulsations ... numerous displacement deliveries per revolution as against one in a single-cylinder piston compressor. Other advantages are: Direct drive; Compact installation; Simple foundations; Maintained capacity and efficiency; and No valves to leak. Because there are few moving parts—rotor, blades, and bearings, **maintenance time and costs are negligible.**

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C-218

QUESTIONS on TECHNOLOGY

by W. L. Nelson
Consulting Engineer

Indexes of Various Asphalts

IN last week's issue, the two main asphalt indexes were discussed. By the softening point penetration index (S.P.I.), Mexican asphalts show an index of about 100 whereas by the penetration index (P.I.) the index is about zero. Cracked asphalts have an S.P.I. of about zero and a P.I. of about —2.0. Oxidized asphalts have very high S.P.I. values (120 and higher) and high P.I. values (1.4 to 5).

Specific values are shown in Tables 1, 2 and 3. Various types of asphalts are indicated in Table 1 including cracked and air-blown asphalts. Table 2 shows the relative constancy of the index values for asphalts from one source, and Table 3 indicates the indexes of specific Venezuelan crude oils. Table 4 indicates the susceptibility factors for air-blown asphalts (see also Table 1).

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TABLE 1—ASPHALT INDEXES OF VARIOUS TYPES OF ASPHALTS

Name or source—	Softening point, °F.	Penetration 77/100/5	Indexes S.P.I.	Indexes P.I.	Ref.
Mexican (Panuco)	109-140	39-165	98-110	0.3-0.5	1
Mexican	126	65	90	0	2
Mexican	133	47	92	0.2	3
Mexican	128	60	94	0	1
Mexican	106	180	100	0.5	1
Venezuelan (Mene Grande)	81-155	12-280	65-76	—0.2 to —0.6	1
Venezuelan	123	61	67	—0.6	1
Venezuelan	103	180	47	—0.7	1
Venezuelan	123	65	76	—0.5	2
Venezuelan	128	45	66	—0.6	3
California (Coalinga)	102-131	22-188	14-40	—0.8 to —1.7	1
California (Coalinga and Poso)	117	60	20	—1.5	1
California (Coalinga and Poso)	103	180	47	—0.7	1
California	116	62	14	—1.6	2
California	123	41	20	—1.5	3
Mid-Continent	128	47	70	—0.4	3
Bahrein crude	124	56	64	—0.7	4
Cracked	97	260	...	...	
Cracked (same stock)	138	9	*—38	—2.4	2
Cracked (same stock)	182	2	24	—0.8	2
Air-blown—1 hour	123	118	126	1.5	5
Air-blown—10 hours	154	40	136	2.0	5
Air-blown—15 hours	178	22	138	2.6	5
Air-blown—18 hours	202	15	149	3.3	5
Air-blown—Mexican	159	44	148	2.6	1
Air-blown—Mexican	194	29	High	4.2	1
Air-blown—Venezuelan	165	27	130	2.0	1
Air-blown—Venezuelan	188	23.5	*150	3.4	1
Air-blown—Venezuelan	235	15.5	High	5.2	1
Air-blown—California	149	34	115	1.1	1
Air-blown—California	176	22	135	2.4	1
Air-blown—California	233	13	High	4.8	1
Natural—Bermudez (Vene.)	152	25	102	0.7	6
Natural—Bermudez	139	20	*46	—0.9	6
Natural—Trinidad	206	1.5-4.0	*76	0.8	6
Natural—Trinidad	210	2	*75	0.7	6
Natural—Albanian	250	4	...	3.6	6
Natural—Albanian	222	2	...	1.4	6
Natural—Boeton (Dutch W.I.)	152	18	80	0.1	6

*Approximate.

TABLE 2—CONSTANCY OF ASPHALT INDEXES OF PRODUCTS FROM ONE SOURCE[1]

Penetration 77/100/5	Softening point (°F.)	Indexes S.P.I.	Indexes P.I.	Susceptibility factors A*	Susceptibility factors B*
Mexican distilled (Panuco)					
39	140	100	0.5	2.6	4.2
45	137	101	0.5	2.4	4.2
57	132	104	0.5	2.6	4.1
68	129	110	0.6	2.8	4.2
96	120	106	0.3	3.0	...
110	117	102	0.3	3.0	...
140	111	98	0	3.2	...
165	109	107	0.3	3.3	...
Venezuelan distilled (Mene Grande)					
12.5	155	65	—0.2	...	...
24	142	70	—0.4	...	...
45	128	66	—0.6	...	...
55	125	68	—0.6	...	...
64	122	67	—0.5	...	...
88	117	70	—0.5	...	...
185	104	76	—0.6	...	...
280	81	...	—0.6	...	...
California distilled (Coalinga)					
22	131	14	—1.7	5.5	9.4
35	126	27	—1.4	7.0	8.1
48	121	29	—1.6	7.4	...
52	120	32	—1.4	5.8	...
66	117	31	—1.5	6.6	...
80	114	31	—1.3	7.3	...
97	112	40	—1.1	6.1	...
114	109	40	—1.0	6.3	...
143	106	43	—1.0	5.7	...
188	102	32	—0.8	5.9	...

*Factor A—Ratio of penetations at 77° F. (100/5) to 32° F. (200/60). Factor B—Ratio of penetrations at 115° F. (50/5) to 77° F.

TABLE 3—INDEXES OF SOME VENEZUELAN ASPHALTS

	Crude oil A.P.I.	Crude oil %	Pene. at 77° F.	Soft. point (°F.)	Soft. pt.-pene. index	Pene. index	Susceptibility factor, 77/32
Bachaquero	13.9	52.1	70	117	39	—1.0	...
Bachaquero	14.0	56.0	90	113	38	—1.0	...
Cabimas (La Rosa)	21.9	38.3	85	115	49	—0.9	...
Chimire	34.3	6.7	18	136.5	24	—1.4	3.6
Guara	36.5	11.9	82	123	103	0.3	...
Guico*	38.2	4.8	8.5	147	11	—1.5	1.9
Lagunillas	17.3	52.9	183	99	Neg.	—1.9	...
Nipa	38.8	6.6	14	137	7	—1.8	2.8
Oficina	30.3	18.3	74	119	66	—0.7	...
Oficina	32.4	20.5	79	122	93	0	...
Oficina	26.4	34.2	75	121	82	—0.3	...
Pedernales	20.5	48.8	34	131	55	—0.8	...
Pedernales	21.0	45.8	41	129	61	—0.7	...
Silvestre*	28.8	26.1	22	149.5	86	0.2	2.2
Tia Juana (—102)	26.1	26.1	125	102	Neg.	—2.1	...
Tia Juana	13.3	51.9	101	109	17	—1.5	...
Temblador	22.2	34.3	173	102	4	—1.3	...
Tucupita	16.0	47.8	35	132	60	—0.7	...
Mene Grande	...	...	45	128	66	—0.6	...
Mene Grande	...	...	88	117	70	—0.5	...

*Oliensis test—positive.

TABLE 4—SUSCEPTIBILITY FACTORS OF OXIDIZED ASPHALTS[1]

Source—	Penetration 77/100/5	Soft. point (°F.)	Indexes S.P.I.	Indexes P.I.	Susceptibility factors A	Susceptibility factors B
Mexican	44	159	148	2.6	1.9	1.6
	29	194	High	4.2	2.2	2.1
Venezuelan	27	165	130	2.0	...	...
	23.5	188	*150	3.4	...	...
	15.5	235	High	5.2	...	...
California	34	149	115	1.1	1.9	2.8
	22	176	135	2.4	1.5	2.0
	13	233	High	4.8	1.4	1.5

*Approximate.

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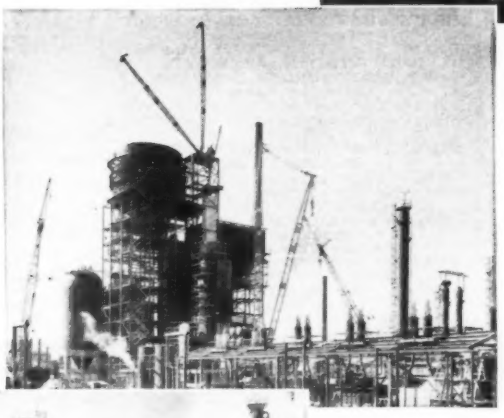

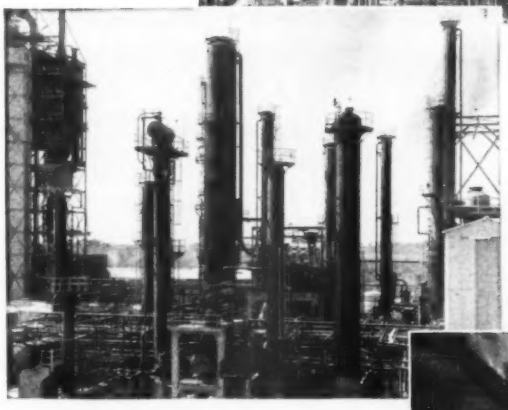

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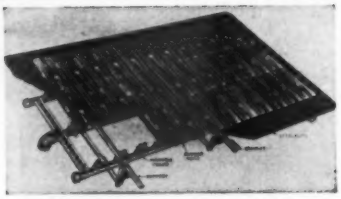

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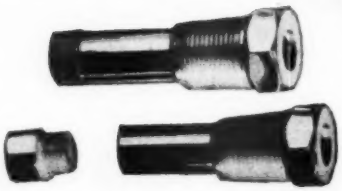

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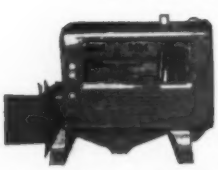
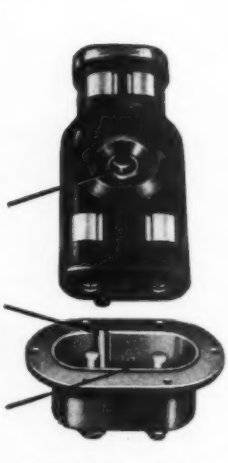


Plug GB-3-21CFS accommodates cables from storage battery in maintenance truck. Made in split rubber shell for easy servicing and soldering. Button energizes starter solenoid switch.



Receptacle GB-3-34CDS of diecast aluminum alloy mounts on engine frame. Two 600-amp. pin contacts; one 40 amp. pin contact. Note polarizing groove.

The shorter 40 amp. pin contact is grounded, disengages first to prevent arcing. It also handles push button solenoid switch circuit.

For complete information request Bulletin GB-648

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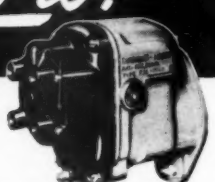

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REFINING

Sulfuric Controls

NPA allocation slated for West Coast supplies

WASHINGTON.—The National Production Authority last week assumed complete control over sulfuric acid supplies in 11 western states and prepared to allocate supplies in the remaining states.

NPA said sulfuric acid in the future cannot be delivered or used without the organization's specific authorization in Washington, California, Oregon, Arizona, New Mexico, Nevada, Wyoming, Montana, Idaho, and Colorado.

The order, designated Schedule 3 to M-45, exempts purchasers of fewer than 61 tons of acid a month. Refiners manufacturing aviation gasoline and various chemicals will be among those affected by the order.

Other areas. — In the remaining 37 states, NPA has directed buyers of acid to certify to their suppliers the end use to which they intend to put the chemical. These suppliers must report to NPA on who their customers are, how much they bought, and for what purposes. Reports from suppliers are due in on the tenth day of the month before the proposed delivery month.

The reporting mechanism is needed, NPA said, to give a clearer picture of the national pattern of sulfuric acid use. The authority said it would then be in a better position to devise an ultimate method of national control.

Spent acid exempt.—The order does not require authorization to use spent acid, except when used in combination with other materials to make salable products. Deliveries may be made to the original supplier without NPA approval. However, the supplier must apply to redeliver and use spent acid for all purposes except "fortification" or "decomposition."

Tighter controls are being clamped on sulfuric acids on the West Coast because of a lack of productive capacity to meet local needs and difficulty in transporting it from plants in other parts of the country, NPA said.

Chemical Plant Announced

PAMPA, Tex.—Celanese Corp. of America announced plans last week for the construction of a modern chemical plant here.

Harold Blancke, president, said the plant will use hydrocarbon feed stocks for chemical processing and natural gas for fuel in producing materials to be used in the manufacture of yarns, plastics, synthetic rubber, explosives, and pharmaceuticals.

The process to be utilized at the plant was developed through petroleum-chemical research and development work carried out in the Celanese laboratories at Clarkwood, Tex.

Blancke said that output of the new plant would supplement chemical-production facilities at the company's Bishop, Tex., plant. The Pampa site is 50 miles east of Amarillo in West Texas.

Canadian Chemical Co., Ltd., an affiliate, will begin construction soon of a plant in Edmonton, Alta., also for the production of petro-chemicals.

Shell Buys Refinery Site

NEW YORK.—Shell Oil Co. has acquired the site at Woodbridge, N. J., for a large East Coast refinery to be constructed when the shortage of steel is eased.

H. S. M. Burns, company president, told stockholders at the annual meeting in New York that Shell does not plan to begin construction for at least another year. Burns said the company's other refineries are in a position to meet current demands for oil products and an East Coast refinery would represent surplus capacity at present.

No official announcement has been made as to the size of the new plant.

W.P.C. Refining Papers

Advances in petrochemical operations and developments in improved petroleum-based products will be presented under several major divisions at the third World Petroleum Congress to be held May 28-June 6 at The Hague, the Netherlands. Included in the total list are the following papers, all to be distributed in preprint form at the sessions:

"Synthetic Detergents From Petroleum," W. K. Griesinger and A. B. Hersberger, U.S.A.; "Properties and Applications of Petroleum Derived Synthetic Detergents," A. H. Lewis, A. L. Meader, and D. F. Searle, U.S.A.; "Use of Petroleum Oils as Herbicides in Great Britain," G. W. Ivens, E. K. Woodford, and G. E. Blackman, U.K.; "Toxicity of Herbicidal Oils," A. S. Crafts, H. B. Currier, and O. A. Leonard, U.S.A.

"A New Chemical Industry Based on Allyl Chloride," D. L. Yabroff and J. Anderson, U.S.A.; "Properties and Applications of Solvents Synthesized From Petroleum Raw Materials," J. G. Dickerson, U.S.A.; "La Chloration dans la Valorisation des Hydrocarbures," M. Georges Souillard and J. C. Jungers, France; "Oil Carbon Blacks in Rubber Compounding," R. W. Leslie and W. B. Reynolds, U.S.A.

"The Oxo Process. Research, Development, and Product Application," H. Hoog, the Netherlands; "Utilisation Chimique du Methane par Pyrolise," C. Padovani, Italy; "Petroleum in Wood Preservation," J. A. Vaughan, U.S.A.; "Surface-Active Agents From Petroleum—History and Statistics,"

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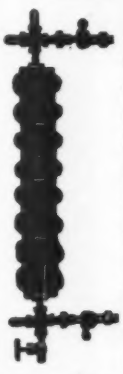

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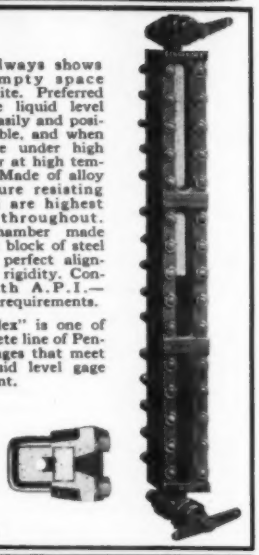

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John R. Skeen and Foster Dee Snell, U.S.A.: "Detergents From Petroleum — Production and Properties," Foster Dee Snell and Irving Reich, U.S.A.

Plant Nears Completion

HOUSTON.—Lubrizol Corp.'s new $2,000,000 plant now under construction here will be in operation by the end of May.

The new plant, which adjoins Shell Chemical Corp.'s plant at Deer Park, will produce additives used by refining companies in the manufacture of lubricating oil. Principal ingredients for manufacturing additives are obtained from chemical plants.

M. R. Clapp, general manager of the plant, said that actual construction work has been completed.

Lubrizol Corp. selected Houston as site for the plant because, according to Kent H. Smith, president, the city is the center of the world's largest refining area and the locale of a growing chemical industry.

Shell Plans Platformer

HOUSTON.—The installation of a large Platforming unit for the production of aviation aromatics and benzene at the Houston refinery is being considered by Shell Oil Co.

At present, company officials are discussing the need for such a plant with Petroleum Administration for Defense officials in Washington. Actual construction of the plant is contingent upon PAD approval.

Solvay Detergent Output

NEW YORK.—Additional details on a synthetic-detergent process which will continue unaffected by current benzene and chlorine shortages have been released by Solvay Process Division, Allied Chemical & Dye Corp. The new detergent, Nytron, is produced from petroleum, rock salt, and nitric acid.

Solvay employs a thermal cracking unit at the Hopewell, Va., plant. Designed by Solvay engineers, the unit charges petrolatum, and pressure and temperature conditions are maintained to produce a maximum of light olefins. After separation, these basic olefins are then reacted with nitrosyl chloride for production of the finished detergent. Nitrosyl chloride, a byproduct of the Solvay chlorine operation at Hopewell, is derived from the reaction of rock salt with nitric acid, an exclusive Solvay process.

The operation is not new, but the new approach it represents to detergent manufacture is expected to loom important in the coming period of short supply for most other detergent operations. Developed in the company's laboratories over a period of many years, the operation has been conducted on a commercial scale for the past 3 years.

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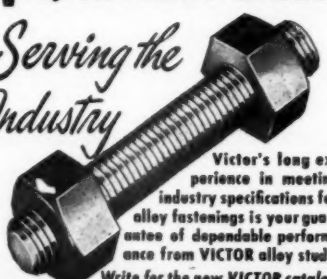

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NATURAL GAS

Storage Laws

Firms get condemnation rights in new state laws

THE trend in state legislatures toward approval of bills granting the right of eminent domain to natural-gas companies seeking property for underground gas-storage projects appears to be gaining ground.

In less than a month, legislative bodies of two major gas-producing states, Oklahoma and Kansas, have acted favorably on underground-storage legislation.

At Oklahoma City last week, the Oklahoma Senate passed such a bill by a vote of 31 to 5. This was a complete reversal of the position taken 2 years ago when the senate killed a similar bill. It will now go before the state house of representatives.

Public welfare. — The Oklahoma measure was based on reasoning that public interest and welfare is promoted by underground storage of gas, in that it aids in conservation and permits building of reserves for orderly withdrawal during periods of peak demand.

The measure provides procedure for a company to condemn for storage any subsurface formation which the Oklahoma Corporation Commission finds suitable and in the public interest. The company must first obtain permission from the commission before going into District Court to condemn a formation.

The senate was told in hearings that the right to condemn was needed because many times land owners cannot be found to negotiate contracts. Only oil and gas sands that were depleted would be used.

A similar bill providing gas companies with the right to condemn for underground storage in Kansas recently was enacted by the Kansas Legislature.

Gas Licensing Endorsed

WASHINGTON.—Chairman Mon C. Wallgren of the Federal Power Commission last week endorsed a proposal that the commission collect fees for the issuance of natural-gas licenses in order to help defray expenses.

Wallgren made the statement in reply to a question asked by Rep. Albert Thomas (D.-Tex.) during hearings by a House appropriations subcommittee on FPC appropriation requests for the year starting July 1.

Thomas asked if there were any good reasons why FPC should not collect fees to help pay the commission's expenses in activities dealing with the regulation and granting of licenses of natural-gas lines. Wallgren said he thought FPC should collect fees. He added that FPC had sent a report to a Senate subcommittee which is investigating to determine whether or not there is any possible revenue that could be derived.

In his budget requests, Wallgren said an increase of $21,000 was needed for work in rate cases, which were given priority over other pending cases by the Natural Gas Act. The commission also asked an increase of $17,500 for its work in issuing certificates of public convenience and necessity.

Wallgren said that consumers currently are saving $44.600,000 a year, or 10 times the commission's entire budget, as a result of FPC action in gas rate cases.

O.N.G. Wins Court Test

OKLAHOMA CITY.—The Oklahoma Supreme Court last week overruled a District Court order requiring Oklahoma Natural Gas Co. of Tulsa, to provide gas service "without discrimination" to five state glass companies.

Justice Earl Welch, who wrote the opinion, said Judge Kenneth Hughes, of Creek County District Court, exceeded his jurisdiction when he granted a writ of mandamus to the glass companies to compel O.N.G. to furnish gas "suitable to our needs and without discrimination." Case was ordered returned to the lower court for dismissal.

The decision was handed down soon after an Oklahoma Corporation Commission hearing on a contempt citation against O.N.G. was continued until May 22. The contempt hearing grew out of curtailment by the company of gas service to industries in the state during cold spells in January and again in March. The contempt charge followed a state senate committee investigation.

Joseph Bowes, O. N. G. president, said in a prepared statement to the commission that every contract filed by the company with the commission in his 15 years with O.N.G. had contained provision for cutbacks in case of necessity.

Transco Nears Capacity

HOUSTON. — Transcontinental Gas Pipe Line Corp. has announced plans to apply soon to the Federal Power Commission for authority to further expand its gas-carrying system.

Claude A. Williams, president, said that demand for natural gas from the Transcontinental system would equal capacity by the time the application is submitted.

The company is now delivering about 440,000,000 cu. ft. daily. It expects to increase deliveries to 505,000,000 by the middle of May and to 550,000,000 by fall. Williams said, "Demand for gas has exceeded our wildest estimate."

Emphasizing the big demand, Williams pointed out that Columbia Gas System has asked for delivery of an additional 100,000,000 cu. ft. daily, which Transcontinental would be unable to supply with the present system. Up to the present, deliveries to Columbia principally have been in off-peak months.

Julesburg Gas Sold

COLORADO SPRINGS. — Colorado Interstate Gas Co. is reported to have completed arrangements with British-American Oil Producing Co. and J. M. Huber Corp. for gas produced by those companies in the new fields of the Julesburg basin in northeastern Colorado.

British-American and others have commercial volumes of gas in two wells in the Armstrong area, Logan County. J. M. Huber has two gas wells, now shut in, in Lee pool, Morgan County.

El Paso Contracts for Gas

FARMINGTON, N. M.—Great Lakes Oil & Chemical Co. has announced that El Paso Natural Gas Co. has signed a 20-year contract for gas to be produced from Great Lakes' holding of 4,800 acres in the San Juan area near here.

Great Lakes plans to drill 15 wells to the producing horizon in the Mesa Verde formation at approximately 4,600 ft. Three wells have been completed on the property and gathering lines laid.

Natural Gasoline

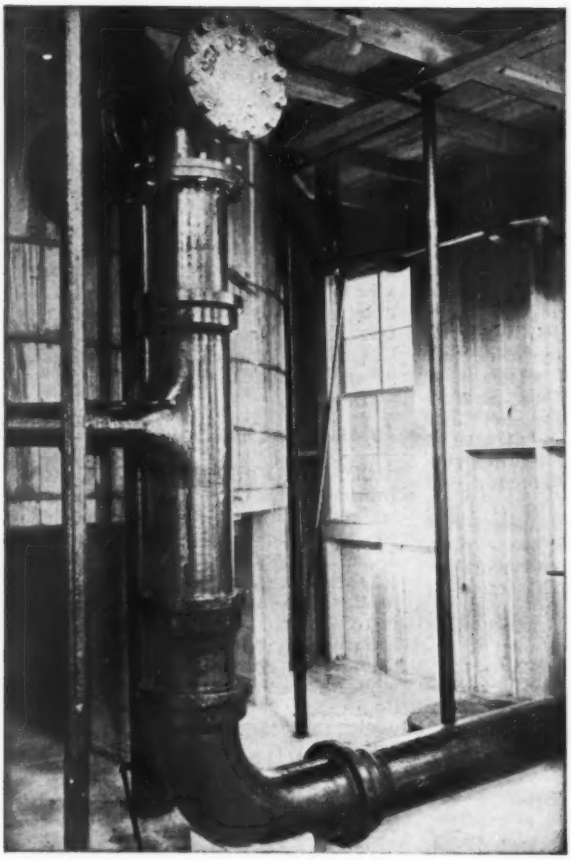
Plant Gets New Compressor

HOUSTON.—Installation of a 2,500-hp. compressor unit has begun at Plymouth Oil Co.'s Welder gasoline plant in Plymouth field, San Patricio County, Texas.

Total compressor capacity at the $2,000,000 plant will be raised to about 6,300 hp. by this latest addition being installed by Hudson Engineering Corp. of Houston.

The new unit will be operated mainly for utilization of low-pressure casing-head gas, and no additional production is anticipated according to Plymouth officials.

The Welder plant is a cycling plant which processes about 48,000,000 cu. ft. of gas per day and has a liquefied-petroleum-gas output of 90,000 gal. per day.



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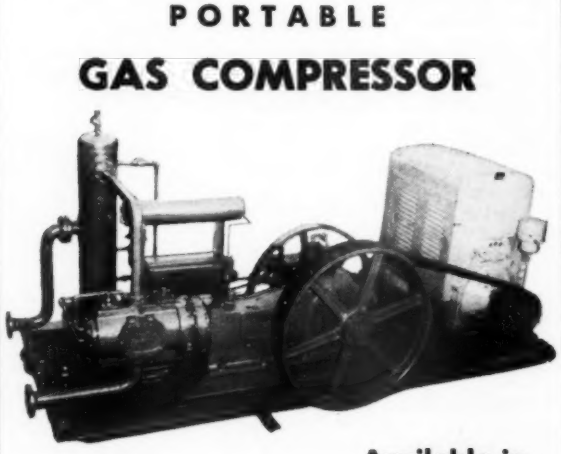

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PIPE LINES

Florida Gas Line Rejected

WASHINGTON.—The Federal Power Commission has rejected an application by South Atlantic Pipe-Lines, Inc., of Jacksonville, Fla., to build a 254 - mile, natural - gas - transmission line in Florida from the Jacksonville area to St. Petersburg.

The commission ruled that the company did not have a definite source of natural gas and was unable to supply information, data, and exhibits required by commission regulations in support of its application. The company had proposed to connect its new lines with other transmission lines in the vicinity of Jacksonville for its supply of natural gas, but FPC said that there is at present no natural-gas line in that area, and none has been authorized.

South Atlantic's project was to have included, in addition to the 254-mile line, about 50 miles of laterals, a compressor station, and necessary metering and regulating equipment.. Total cost was estimated at $23,500,000.

Double-Jointing Planned

O. R. Burden Construction Corp. is making preparations for double-jointing during the laying of the 274-mile, 20-in. Missouri section of the Platte Pipe Line Co. project.

Arrangements have been made with Smith Contracting Corp. for subcontracting the double-jointing for the operations of both spreads of the Burden organization, according to Oscar R. Burden, president.

Double jointing will be done with portable equipment developed by Smith to facilitate handling of pipe for automatic submerged-arc welding in the field. Smith units will proceed ahead of the two Burden spreads forming 80-ft. joints by welding two 40-ft. joints. It is expected that progress of the spreads will be much increased by this double jointing.

Burden will start two spreads from Salisbury, Mo., in May. One spread, to be supervised by Barney Hall, will go east to the Mississippi River; the other under Pete Hiner will go west from Salisbury to the Missouri-Kansas state line. A field office will be established at Moberly, Mo., near Salisbury. The Burden section of the Platte project will be completed in approximately 3 months.

Northeastern Order Stands

WASHINGTON.—Two applications for rehearing of a Federal Power Commission order issued March 21 authorizing Northeastern Gas Transmission Co., of Springfield, Mass., to substitute larger-sized pipe on its main system in Massachusetts have been denied by the commission.

The applications were filed by Texas Eastern Transmission Corp. of Shreveport, and Algonquin Gas Transmission Co., of Boston, Algonquin also has been authorized to build lines in New England to transport gas supplied by Texas Eastern.

The commission ruled that the opinion and order issued March 21 was now final and not subject to review. That order did not authorize Northeastern to serve any additional customers or markets that were not already o.k.'d by the commission's original order last November authorizing construction of the line.

FPC's order in March allowed Northeastern to substitute 24-in. for 20-in. pipe on its 144-mile main-transmission line in Massachusetts, and to substitute larger pipe on five lateral lines in that state.

State Line Case Dismissed

WASHINGTON.—The Federal Power Commission has dismissed the application of State Line Gas Co. of Point Marion, Pa., which sought authorization to sell its natural-gas pipe-line system in Greene and Fayette counties, Pennsylvania to Peoples Natural Gas Co., of Pittsburgh.

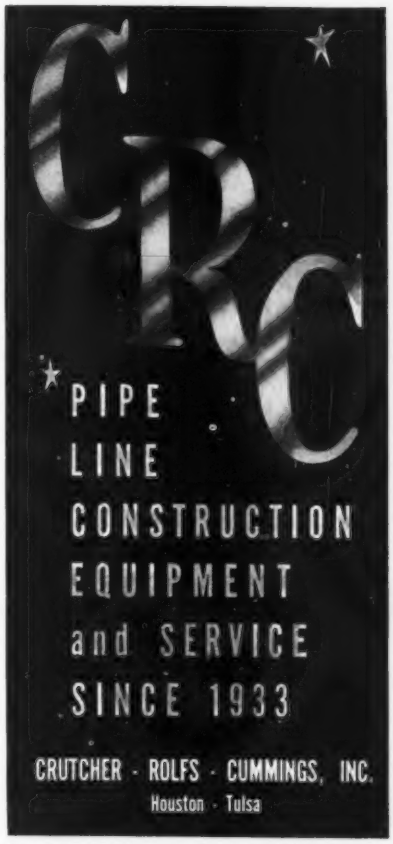
An application by Peoples, insofar as it sought authority to acquire the State Line facilities, was also dismissed. Peoples' application also asked the commission for a declaratory judgment that it either is or is not a "natural-gas company" by reason of any operations in which it is now engaged or proposes to engage.

In dismissing State Line's application, the commission found that its facilities are not used in the transportation of natural gas in interstate commerce subject to FPC jurisdiction.

Kentucky Looping Planned

WASHINGTON.—Central Kentucky Natural Gas Co., of Charleston, W. Va., plans to construct approximately 18½ miles of 12¾-in. loop from Winchester to Lexington, Ky., if the Federal Power Commission approves the proposed project now on its agenda.

The line would cost an estimated $700,000 and would complete the looping of the company's existing 10-in. line from Menifee to Lexington. The company said the construction is necessary to enable it to meet the estimated maximum daily requirements of present customers in its southern division next winter.



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Western Had Its Official Beginning on January 1

WESTERN PIPE LINE CONSTRUCTORS, INC., represents a merger of talents of three executives and key personnel from Morrison Construction Co. and H. C. Price Co. The company is headed by James P. Neill, president; Charles S. LeNoir, vice president; and E. G. Morrison, secretary. Recently George Marsh joined the firm as vice president and treasurer.

J. P. NEILL

The firm undertook some construction ahead of its official beginning on January 1.

Neill, though born in Pennsylvania, is considered a Californian. From Leland Stanford University he went to a ditch gang as laborer for Colorado Interstate Natural Gas Co. Subsequently he was with Ford, Bacon & Davis and Williams Brothers during construction of projects for Mississippi River Fuel Corp., Southern Natural Gas Co., Memphis Natural Gas Co., and Canadian River Gas Co. projects. From 1933 to 1945 he was with Southern Natural Gas Co., first as district foreman and later as superintendent of pipe lines. He headed the pipe-line-construction department of H. C. Price Co. as vice president and general manager in the 1946-50 period.

C. S. LeNOIR

E. G. MORRISON

LeNoir, a Louisianan, worked on the same job with Neill in 1928 when Interstate Natural built the first long-bolted-coupling line. For 5 years he was division foreman for Southern Natural. After nearly 20 years' service with contractors, including Williams Brothers, O. C. Whitaker, and

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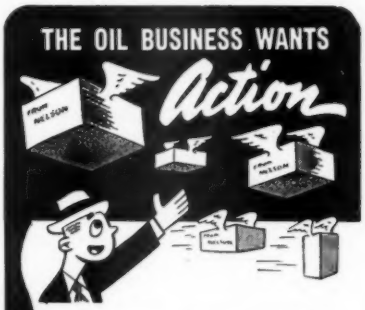

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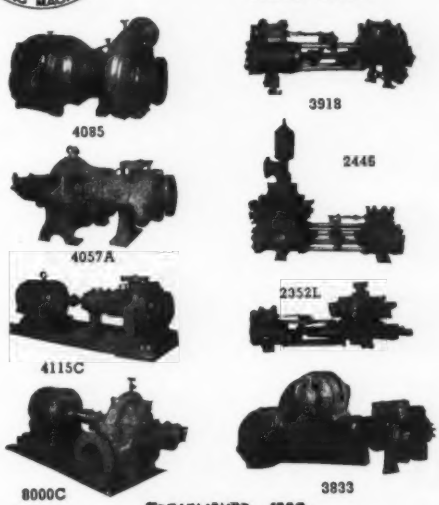

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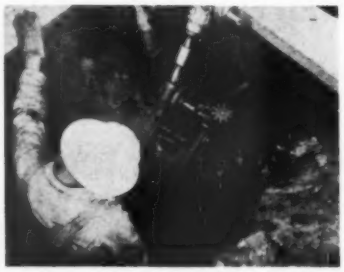

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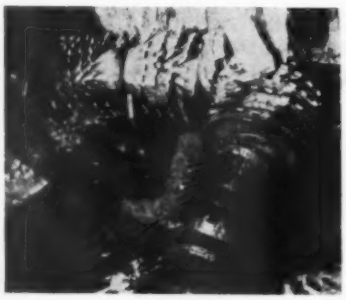

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9059 Venice Blvd., Los Angeles 34, Calif.

I. C. Little, he became general superintendent for H. C. Price Co. in recent years.

Morrison, a Texan, studied at University of Texas and other schools. After working for Humble Pipe Line Co., in West Texas, he left to build up a contracting firm which became prominent in large-scale pipe-line construction in the postwar years.

Marsh resigned from the accounting firm of Wade, Barton & Marsh to become an officer in the new company.

GEORGE MARSH

J. W. FOSTER

Operations.—During the late fall and winter months, Western laid 147 miles of 30-in. for Texas-Illinois Natural Gas Pipeline Co. for the Hungerford-Refugio, Tex., section of the H. C. Price Co. contract program.

Two spreads are now commencing work for Tennessee Gas Transmission Co. for 122 miles of 30-in. in Kentucky and Tennessee, and the laying of major crossings at the Duck, Buffalo, and Tennessee rivers. Altogether Western has booked construction contracts totaling more than $7,000,000.

R. L. McMILLON

JACK HODGES

Equipment.—Western has purchased over $2,000,000 worth of heavy-construction equipment. In addition to the two spreads now in the field, a third spread is being organized.

Staff.—John W. Foster is general office manager. Spread superintendents are W. B. Williams, R. L. McMillon, and Jack Hodges. Headquarters office is in the Lockhart Building, Austin.

Pipe-Line Briefs

Service Pipe Line Co. plans the construction soon of 17 miles of crude-gathering lines in the Talpa area of Runnels and Coleman counties, Texas, to serve the Ogden-Mabee, Burt, and Saxon pools, and 13 miles of outlet from Saunders pool of Lea County, New Mexico.

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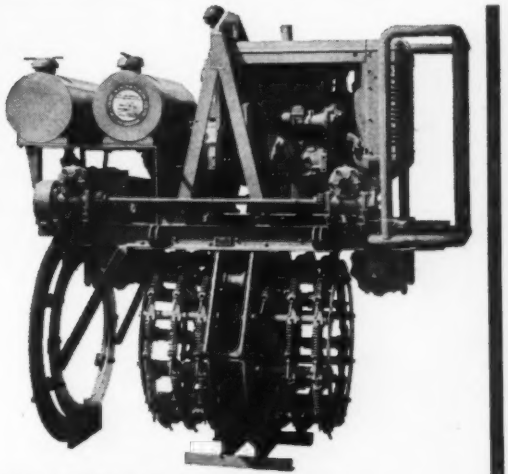

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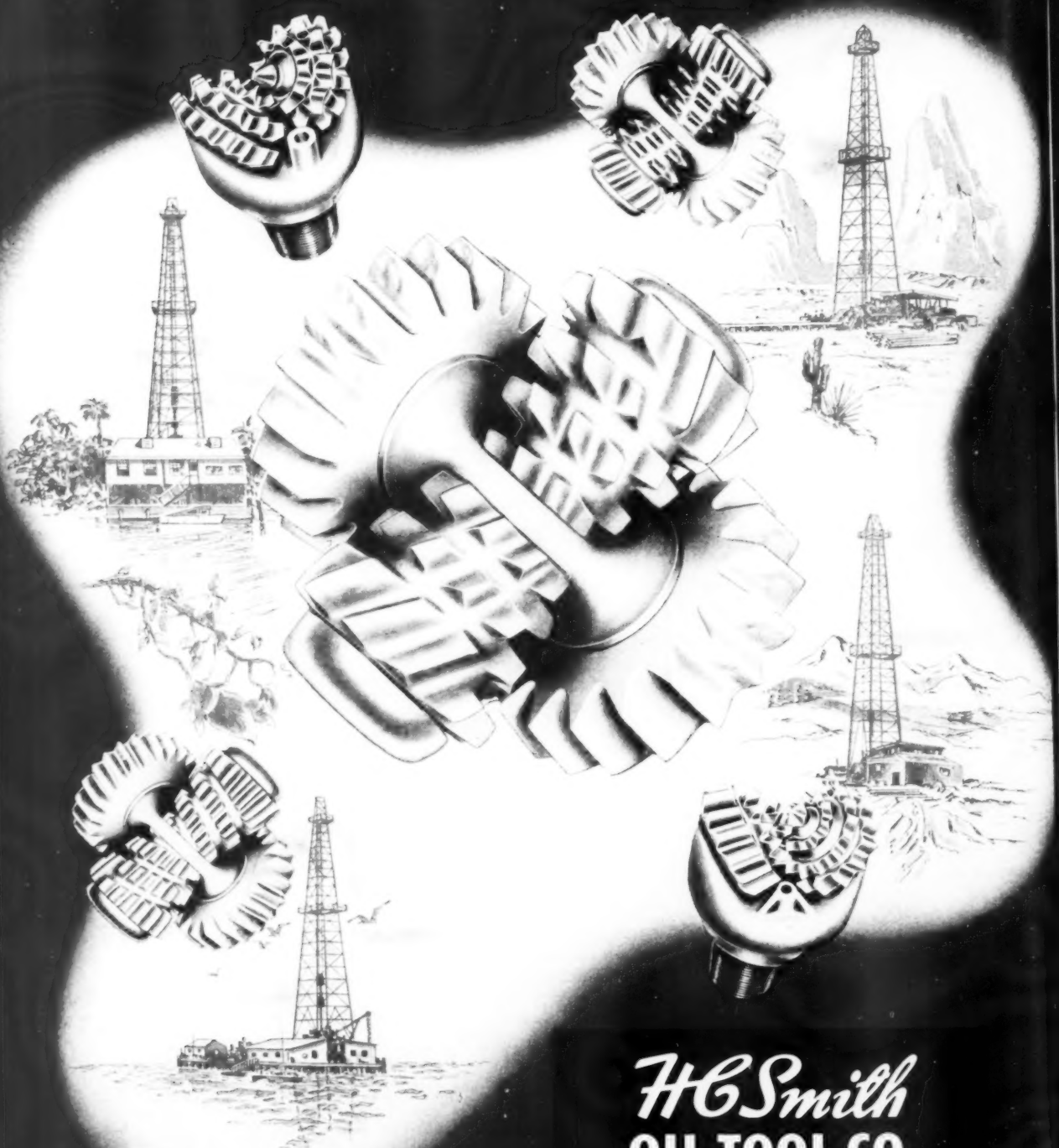

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GENERAL OFFICES, EXPORT OFFICE AND PLANT

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Among the Drilling Contractors

Contractors Exempted From Price Regulation

Exemption of contracts and service charges of drilling contractors, as well as those of professional oil and gas well firefighters, from provisions of the general ceiling price regulations has been authorized by the Office of Price Stabilization, effective April 23. Authorization for the exemption is contained in Amendment 1 to Supplementary Regulation 25 of the OPA.

In granting the exemption, OPA was guided by the fact that there are many unforeseen factors and hazards involved in drilling which create fluctuations in cost, Jeff Boucher, fuels and chemicals branch chief, eastern Oklahoma district, explained. It also recognized that there is a custom in the trade for contractors to receive an interest in a well as part compensation for services, he said.

Professional firefighters have been exempted from ceiling regulations because the prices charged by them is attributable to a large extent to the hazards and risks involved. It was pointed out that there are very few organizations engaged in this profession.

Decem Drilling Co., Oklahoma City, has taken on a Deese sand test to be drilled in the North Lindsay area of southern McClain County. It will drill for Beach & Talbot, a newly formed partnership with offices at Oklahoma City. The new test is 1 Etheridge, with location in the C NE NE 25-5n-4w. Projected depth is 8,500 ft. The same operators are starting an Arbuckle lime test in the Northwest Burnett pool, Ellis County, Kansas, where **Harbar Drilling Co.,** Wichita, has the contract.

Norman T. Smith is the contractor on another Hunton lime test which Vern Nellis and associates are starting in the Northwest Earlsboro pool, Pottawatomie County, Oklahoma. The new operation, 1 Karger, SW SW NW 1-9n-4e, offsets a well completed by the same operators last February.

Corbett-Barbour Drilling Co., Tulsa, has moved a rotary rig to a wildcat location 2 miles south of Red Rock, Noble County, Oklahoma, where it will drill for Flynn Oil Co. Location of the new test, 1 Wilson, in the NW NW SE 34-23n-1e, is 3 miles north of the East Otoe City pool, nearest production. The Layton sand objective is expected around 3,400 ft.

Tom Grimmett, contractor on Gulf Coast Western Oil Co.'s recently completed gas discovery well between the North Deaner and Fields pools in Okfuskee County, Oklahoma, has moved his rig to a location ½ mile northwest for another test. The new test is 1 Lambert, SW SW SW 3-11n-11e. The discovery well, 1 Pharaoh, NW NW NE 10-11n-11e, produces from Gilcrease sand at 2,613-19 ft.

Larsco Drilling Co., Oklahoma City, is drilling for Delta Petroleum Corp. at 1 Kline, a wildcat test in the NW SE SE 32-22n-3e, western Pawnee County, Oklahoma. Hole is projected to 4,325 ft.

Veeder Supply & Development Co., Cherryvale, Kans., has the drilling contract on a rank wildcat test which Harry Gore is starting in Ness County, western Kansas. Location is in the SW SW SW 15-19-21, 30 miles from nearest production. The test is 1 Brentz.

Loffland Brothers Co., Tulsa, has been awarded the contract for the deep wildcat test which Signal Oil & Gas Co. is planning to drill in the C. NW SW 27-22n-17w, Woodward County, northwestern Oklahoma.

Kemp Drilling Co., Shreveport, is starting two additional tests in Adams County, Mississippi. One, located in the Kingston area, is being drilled under contract with Magnolia Petroleum Co. Location is in 11-5n-2w, on the Swayze-Benoist unit. Contract is for 6,800 ft. The other, located in 62-7n-2w, a mile north of the LaGrange field, is being drilled for its own account. It is projected to 7,000 ft. as a Wilcox test.

Nuckolls-Bell Drilling Co., Oklahoma City, is keeping a rig busy for Carter Oil Co. in the East Sparks pool, Lincoln County, Oklahoma, where active development of Prue sand production is continuing. Latest well started by this company is Carter's 5 State-Moore, NW NW NW 16-13n-5e.

H. O. Grace Drilling Co., Wichita Falls, Tex., is drilling for Conrad Sztykgold at 1 Wilson Estate, Lot 11, Block 44, ATNCL Survey, a wildcat 1½ miles southeast of the Hull-Silk field, in Archer County, North Texas.

Mohawk Drilling Co., Oklahoma City, has contracted for a well to be drilled for Friedlander & Barbara at

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Prevents pipe threads from galling and seizing—protects threads—lengthens life of drill string. Those are reasons why 'Bestolife Lead Seal Tool Joint and Casing Compound has been tops in the oil country for 20 years. Unconditionally guaranteed. Sold and exported by supply houses the world over.

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an outpost location west of production on the southwest side of the West Arno pool, on the Creek-Okfuskee county line, in Oklahoma. The location at 1 Whitney in the NE NE NW 3-13n-7e is on the Okfuskee County side. Pool production is at depths of 2,600 ft. in the Prue sand and 3,000 ft. in the Red Rock sand.

Seaboard Drilling Co. is the contractor on a Dutcher sand test being started by Toklan Production Co. in the Big Pond pool area, in southwestern Creek County. Location is for 1 Strein, SW NW NE 1-14n-7e.

Noble Drilling Co., Tulsa, has a rig working on deep wildcat test located 20 miles northeast of Fort Davis, Jeff Davis County, in far western Texas. The test, 1-A McCutcheon, is being drilled for Stanolind Oil & Gas Co. Contract is for 10,500 ft.

K & E Drilling Co., Inc., Wichita, has a rig on a wildcat location 1½ miles southeast of the Glenwood pool, Phillips County, Kansas, where it is drilling under contract for Imperial Petroleum Co. and Bay Petroleum Corp. Location is on the Allen lease in the SE NE NW 27-1-17.

Mercury Drilling Co., Tulsa, has contracts for two additional wells which Bay Petroleum Corp. has projected for the Doyle pool area in Stephens County, Oklahoma. Rig has been moved in for the first, 1-G Payne, NW SE SW 2-1n-5w.

E. A. Rumley Drilling Co., Oklahoma City, is drilling at a wildcat location northeast of Lexington, Cleveland County, Oklahoma, where it has a contract with Ashland Oil & Refining Co. for a second Wilcox sand or 7,100-ft. test. Location is in the C NE SE 23-7n-1w.

Alton Coats Drilling Co., Gladewater, Tex., is drilling a projected 5,300-ft. test for J. M. DeuPree and F. R. Jackson at 1 H. A. Godwin, in the J. P. Henderson Survey, Wood County, Eastern Texas.

ROTARY RIGS IN OPERATION*

(United States and Western Canada)

Area—	Week ended 4-16-51	Change week ended 4-9-51	Change week ended 4-17-50
Gulf Coast	541	+17	+ 42
W. Tex.-N. M.	846	+14	+128
Ark.-N. La.-E. Tex.	134	— 4	+ 17
Oklahoma	292	— 8	+ 31
Kansas-S. Nebraska	155	— 2	+ 35
Illinois-Eastern	63	—20	— 28
Rocky Mountains	115	—10	+ 52
Pacific Coast	157	+11	+ 26
Total United States	2,303	— 2	+303
Western Canada	100	— 4	+ 37
Total	2,403	— 6	+340

*Courtesy Hughes Tool Co. Trends in drilling activity in the United States as a whole and the Pacific Coast and Illinois-Eastern areas are shown by charts on pages 236 and 237.

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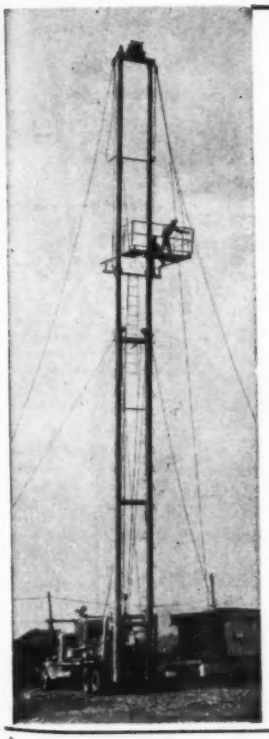

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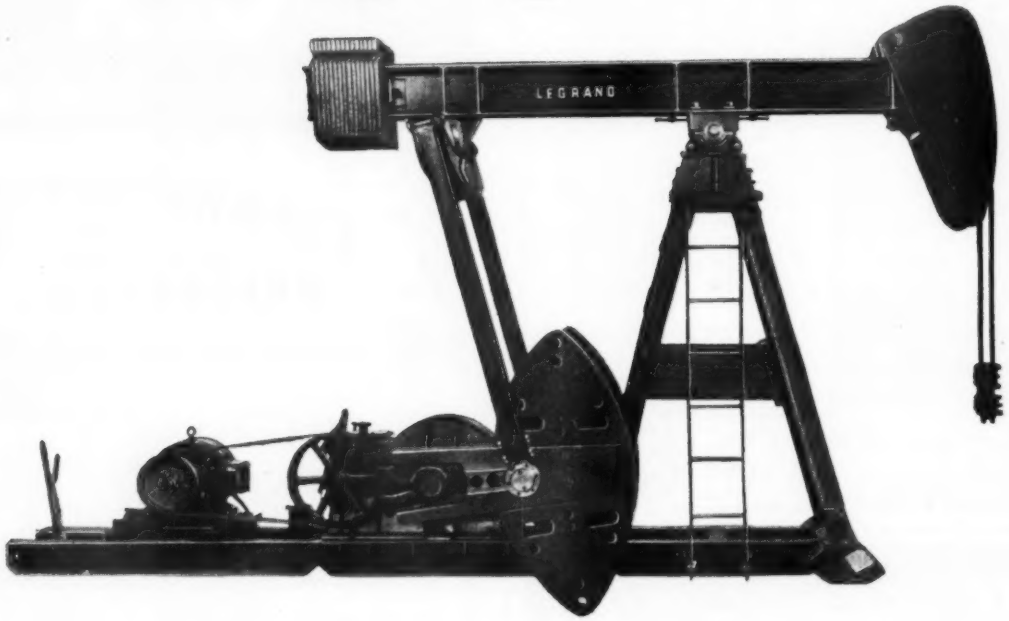

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Why Is Oil Where It Is?

EVER since it became apparent that a cut-and-dried version of the structural theory of oil accumulation could not answer all of the questions arising from known pools nor account for the lack of accumulation in "ideal" structures, geologists have been hunting for the answer to "why is oil where it is?"

Many geologists consider the structural theory of accumulation so unsatisfactory that they want to begin all over again, but lack sufficient data to postulate a new, workable theory. These geologists are going to be extremely interested in a paper to be presented by Paul D. Krynine of Pennsylvania State College's oil-finding unit at the St. Louis meeting of exploration scientists. The theory to be presented by Krynine throws the present interpretations and variations of the structural theory of accumulation out the window, but at the same time retains the idea that a definite relationship between oil sands and structural highs exists. Just how this paper will be received remains to be seen, but it's safe to say that it won't go by without provoking considerable valuable discussion. Here's a little background that is necessary to appreciate the significance of the ideas contained in the new concept.

The first clear statement of the anticlinal theory of oil accumulation was published shortly after the discovery of oil by drilling. This theory was soon attacked and strong opposition to it continued for the next 25 or 30 years. This opposition, however, probably because of inadequate data, failed to develop a theory that could account for the occurrence of oil pools.* Meanwhile the anticlinal theory piled up evidence in its favor even though some oil was being found in scattered pools downdip from the crests of major anticlines and even in synclines.

As the demand for petroleum took its sudden upswing with the need for gasoline by the increasing use of automobiles, and the search for more and more oil led geologists to new regions, the anticlinal theory gained popularity because of its apparent simplicity and applicability to field work. Geologists sought closed structures. They found them in plenty and got them drilled; many of the structures produced oil and gas, but some were barren or water-bearing. This increased search showed that it wasn't only anticlines that produced oil, but noses, fault-line areas, salt domes, and sand lenses. Accumulations in all of these features, however, seemed to fit readily into the by-then-called "structural theory."

As the search for structures went on, some oil continued to be found where there was no apparent structure. It was also proved that the oil-bearing outlines did not always follow structural contours even when on structure, and that some sand lenses were completely saturated with oil. Evidence kept building up that the structural theory of accumulation was at least not the entire answer.

In the early thirties the stratigraphic trap was recognized. Surface expressions of most stratigraphic traps are nonexistent and geophysical exploration, which grew up keyed to the structural theory, was suddenly faced with a new problem.

Some geologists began to look on all oil-bearing reservoirs as a combination of structural and stratigraphic traps; others went so far as to consider all oil-bearing traps as basically stratigraphic. Right now there is no theory of oil accumulation that enjoys complete acceptance. Though it has been rather convincingly demonstrated that structures that existed at the time of deposition of the oil-bearing beds (recognized by a decided thinning across the structure) are the ones to drill to find oil, the evidence of any "high" is still considered sufficient for many wildcat locations.

Krynine's "relative theory of oil accumulation in specific reservoirs" and its reception by geologists who have long studied the unsolved problems of accumulation will be reported on this page next week.

Philip C. Ingalls

*It has since been shown that the localization of oil and gas into some of the major fields of western Pennsylvania, which were the subject of the controversy, does not in any way conform to the anticlinal structures in the rocks.

HIGHLIGHTS OF WEEK'S DEVELOPMENTS

WEST TEXAS.—First 22 hours on completion test at The Texas Co. 1-B Scharbauer, Midland County Pennsylvanian wildcat, produced 614 bbl. of 55°-gravity oil through 24/64-in. choke from pay at 10,290-10,325, and 10,345-10,470 ft. Nearest production is Parks field, 3 miles to the southwest. The Texas Co. 1 Scharbauer, 4 miles to the northwest, opened Warfield Ellenburger pool.

EAST TEXAS.—Continental Oil Co. completed its 1 Carroll as a gas-distillate discovery in Anderson County for a calculated potential of 90,000,000 cu. ft. of gas a day, open flow, plus 65 bbl. of distillate per 1,000,000 cu. ft.

ROCKY MOUNTAIN AREA.—Ohio Oil Co. has its seventh discovery, in Cheyenne County, Nebraska. The company's Johnson area well found oil in three sands of the Graneros. Amerada Petroleum Corp. has reacidized its North Dakota discovery and is continuing to test. General Petroleum Corp. is testing Frontier shows at the Tip Top, Wyoming, discovery, prior to completion as a Nugget sand oil producer.

SOUTHWEST TEXAS.—Newman Brothers Drilling Co. and Alaska Steamship Co. have an apparent discovery at their 1 Craig in McMullen County. The test recovered gas-condensate on drill-stem tests in the Wilcox at 5,260-86 ft., 5,475½-82 ft., and 5,484½-91 ft.

CANADA.—Natural gas has been recovered at an offset to C.P.R.L.-Ellerslie 1, Lower Cretaceous oil strike. Running 11 ft. higher than the discovery, Midland Petroleums, Ltd.-Meek 1 tested gas at the rate of 3,700,000 cu. ft. per day with an oil spray at 3,900-07 ft. in the same pay horizon as the first Ellerslie area success.

XUM

Southwest Texas

Drill-Stem Tests Indicate Gas-Condensate Discovery

CORPUS CHRISTI. — Newman Brothers Drilling Co. and Alaska Steamship Co. have apparently discovered gas-condensate production in southwestern McMullen County at 1 Mrs. Ethel Lowe Craig. The wildcat is now drilling below 5,595 ft. after testing gas-condensate on two drill-stem tests in the Wilcox zone. Through perforations in the Middle Wilcox at 5,260-86 ft., the well recovered 30 ft. of condensate-cut mud and developed 460 psi. working pressure. A later drill-stem test at 5,475½-82 ft., using ¼-in. chokes and open 1 hour, developed 56 psi. working pressure and recovered 150 ft. of gas-cut mud. Another test at 5,484½-91 ft., using ¼-in. chokes, and open 21 minutes, developed maximum working pressure of 1,040 psi. and recovered 15 ft. of condensate. Drill-stem test in the bottom sand at 5,492-504 ft., using ¼-in. chokes, recovered 3,180 ft. of salt water. This prospective discovery is located in J. Poitevent Survey 17, Abstract 366, on an Amerada farmout, 6 miles northeast of Green Branch field.

D. H. Byrd has run tubing in 1 M. Blakely, Gause area wildcat in Milam County, and is preparing to put the well on pump for completion in the Edwards lime at 5,736-39 ft. Drill-stem test at that interval, which is open hole, recovered 3,680 ft. of oil and 1,620 ft. of salt water. Previous test through perforations in the Georgetown lime at 5,711-15 ft. recovered 2,430 ft. of 32°-gravity, greenish-brown sweet oil. However, operator discovered that the well had been channeling behind the casing between the Edwards lime and Georgetown lime, and that the fluid actually came from the Edwards lime section. Therefore, perforations were squeezed off and operator is preparing to complete in open hole at 5,736-39 ft. This discovery is in A. J. Watts Survey, 3 miles west of Gause.

Drill-stem test in James R. Dougherty 1 W. R. Peters, wildcat, C.C.D. Co. Survey 66, A-693, Duval County, indicated what apparently will be a major extension to the Cole sand production in Hoffman field. Through perforations at 2,205-20 ft. in the Lower Cole, the well developed 10 psi. working pressure and recovered 125 ft. of oil through ⅜-in. and ¼-in. chokes. This well is located 1¾ miles southwest of previous Cole sand production at Hoffman-Extension field.

New gas pay is being opened in Amargosa field, Jim Wells County, at George W. Graham 1 Rescendez, J. Poitevent Survey 97, A-361. On drill-stem test at 5,976-86 ft., the well developed 700 psi. working pressure, and flowed gas with no gage. Operator is preparing to perforate at 5,968-75 ft. for completion in a new gas sand for the field.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) SUCCESSFUL WILDCAT

Jim Hogg County: Oil discovery—Sun Oil Co. 11 A. C. Jones, Agua Nueva de Abajo Grant, 3½ mi. S-SW of East Jones discovery well, TD 4,610 ft., perf. Hockley 4,574-32 ft., IP: 117 bbl. oil per day, ½-in. choke, TP 590 psi., CP 800 psi., 45.5° gravity.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) WILDCAT FAILURES

Jim Hogg County: Gorman-DeLange 1 Chas. Reeve Heirs, Sur. 272, A-313, dry, TD 3,377 ft.

Humble Oil & Refining Co. B-1 E. B. Atwood, Santa Antonio Viejo Grant, A-327, dry, TD 6,000 ft.

O. W. Killam 1 Reuben Holbein, Sr., Block 17, Hogg Ridge Subd., Las Animas Grant, dry, TD 3,537 ft.

O. W. Killam 1-A Reuben Holbein, Sr., Block 17, Hogg Ridge Subd., Las Animas Grant, dry, TD 3,393 ft.

Sun Oil Co. 16 A. C. Jones, Agua Nueva de Abajo Grant (J. M. Ramirez Sur.) A-258, dry, TD 4,889 ft.

Medina County: Howard E. Nessly 1 Nessly fee, Stephens Koch Sur. 94, 6 mi. NW of Hondo, dry, TD 900 ft.

Webb County: Dulaney Oil Co. 1 Raul de la Garza, Sur. 48, 12 mi. NE of Oilton, dry, TD 2,757 ft.

North Central Texas

Shackelford County Wildcat Completed in Ellenburger

WICHITA FALLS. — Shackelford County gained a successful wildcat completion this week at C. W. Gore 1 Dean Bros., 1½ miles northwest of Sedwick, and about 1 mile northwest of Ellenburger production, but separated from that area by two dry holes. Top of pay and top of the Ellenburger were 4,234 ft. First drill-stem test from 4,235-43 ft. had oil in 13 minutes, estimated at 40 bbl. an hour, under flowing pressure of 1,170 psi. The well's 12-hour test would give it a daily potential of 672 bbl. of oil.

Last reported test at Humble Oil & Refining Co. 1 W. F. Harrell, Haskell County wildcat southwest of Weinert, was a gage of 61.87 bbl. of oil in 17 hours.

Continental Oil Co. continued testing at its 1 Maggie Martin, Haskell County conglomerate discovery 3 miles southwest of Rochester. The well was drilled to 6,107 ft., in the Ellenburger, then casing was set and perforated from 5,692-5,800 ft. After being swabbed out, the well kicked off and flowed 129 bbl. of oil in 6 hours through 40/64-in. choke. Flowing tubing pressure was 200 psi.

NORTH CENTRAL TEXAS (DISTRICTS 9 AND 7-B) SUCCESSFUL WILDCATS

Archer County: San Juan Oil Co. 1 S. L. Scott, Thos. McCoy Sur., 5 mi. N Olney, TD 5,527 ft., Caddo 4,740 ft., perf. 4,780-94 ft., IP pumped 81.6 bbl. oil a day.

Eastland County: Wm. L. Dickson 1-A J. H. Nix, W. H. Stoneham Sur., 7 mi. N Eastland, TD 1,992 ft., pay 1,960 ft., IP pumped 2 bbl. oil.

G. E. Kadane & Sons 1 Sneed, 20-4-H&TC, 6 mi. NW Eastland, TD 3,694 ft., elev. 1,596 ft., Ranger sand 3,673 ft., IP pumped 21 bbl. 40°-gravity oil a day.

W. H. Keasler Oil Co., Inc. 1 A. R. Jennings, J. Rhons Sur., 3 mi. NW Ranger, TD 3,340 ft., Lake sand 3,282 ft., IP pumped 42 bbl. 36°-gravity oil a day.

Fisher County: Stanolind Oil & Gas Co. 1 M. A. Glass, 246-3-H&TC, ½ mi. E Pyron, TD 7,347 ft., elev. 2,397 ft., Ellenburger 7,324 ft., IP flowed 211.4 bbl. oil a day, 12/64-in. choke, TP 335 psi., GOR 370 cu. ft.

Jack County: Star Oil Co. 1 Anna Kinder, SPRR Sur., 5 mi. SE Bryson, TD 4,526 ft., pay 4,433 ft., IP flowed 202 bbl. 42°-gravity oil a day, 16/64-in. choke, GOR 1,750 cu. ft., TP 100 psi.

Shackelford County: C. W. Gore 1 Dean Bros., LAL Sur., 1½ mi. NW Sedwick, TD 4,243 ft., elev. 1,331 ft., Ellenburger 4,234 ft., IP flowed 336 bbl. 47°-gravity oil in 12 hr., 16/64-in. choke, TP 625 psi., GOR 200 cu. ft.

Leonard Smith 1 W. D. Lummas, BOH Sur., 3½ mi. S Ibex, TD 2,470 ft., pay 2,032 ft., IP 5 bbl. oil.

Throckmorton County: Cities Service Oil Co. 1 Swenson 210, Sec. 210, BBB&C, 9 mi. NW Throckmorton, TD 5,511 ft., elev. 1,515 ft., Caddo 4,766 ft., pay 4,774-84 ft., IP pumped 67.4 bbl. 39°-gravity oil a day.

Drilling & Exploration Co., Inc. 1-C Richardson Trust, BBB&C Sur., 10 mi. N Throckmorton, TD 5,124 ft., elev. 1,344 ft., Caddo 4,545 ft., IP pumped 42 bbl. 39-°gravity oil.

NORTH CENTRAL TEXAS (DISTRICTS 9 AND 7-B) WILDCAT FAILURES

Archer County: R. W. Darden 1 D. L. Bishop, W. E. Probert Sur., 1 mi. NE Megargel, dry, TD 1,328 ft.

R. W. Darden 1 D. Evans, Wm. Ainsworth Sur., 5 mi. W Anarene, dry, TD 1,304 ft.

R. W. Darden 1 E. E. Kunkel, Wm. Ainsworth Sur., 8½ mi. NE Megargel, dry, TD 951 ft.

S. D. Johnson 10 Frank Henry, Clark & Plumb Subd., Lot 20, dry, TD 3,651 ft.

W. A. Loftin & Frank Mort 1 Otto Stehlik, Denton CSL, 1 mi. NW Holliday, dry, TD 1,855 ft.

Meredith & Snebold 2 J. R. Parkey, SP-RR Sur., 3 mi. SE Mankins, dry, TD 1,696 ft.

Neeld & Hood 1 W. H. Taylor, ATNCL Sur., 4 mi. SW Holliday, dry, TD 1,650 ft.

Reno Oil Co. 1-B Stathers, ATNCL Sur., 8½ mi. SW Holliday, dry, TD 4,352 ft., to be used as gas injector well.

Baylor County: Bridwell Oil Co. 1 Fred Musgrove, T&NO Sur., 2½ mi. SE Seymour- dry, TD 5,514 ft.

Brown County: The Trieng Co. 1 H. B. Woodley, E. R. Myers Sur., ½ mi. SW Brooksmith, dry, TD 540 ft.

Clay County: L. T. Burns 2-A Vietenheimer, Clark & Plumb, 6 mi. SE Scotland, dry, TD 4,550 ft.

Hull Oil Co. 1 Allen Rodgers, Alex McGowan Sur., 3 mi. NW Petrolia, dry, TD 2,011 ft.

Coleman County: R. W. McKissick 1 Byron, BBB&C Sur., 5 mi. NW Coleman, dry, TD 3,047 ft.

Dale Smith 1 Winona Stovall, Wm. Mason Sur., 9 mi. W Burkett, dry, TD 2,063 ft.

Cooke County: Lee Hicks 1 Joe Starke, Henry Dixon Sur., 4 mi. NE Muenster, dry, TD 3,260 ft. in the Ellenburger.

Seitz, Commegys & Seitz et al 1 Dennis, A. Pope Sur., 3 mi. W Bulcher, dry, TD 2,493 ft.

M. P. Wilson et al 1-A S. D. Meadors, G. Long Sur., 6 mi. NW Muenster ,dry, TD 2,217 ft.

Fisher County: Lion Oil Co. 1 Lanning, 10-20-T&P, 2½ mi. NW Eskota field, dry, TD 6,160 ft., Strawn 5,087 ft., Caddo 5,550 ft.

Hamilton County: Amerada Petroleum Corp. 1 G. L. Blythe, N. B. Hawkins Sur., 5 mi. W Hamilton, dry, TD 3,468 ft., elev. 1,287 ft., Marble Falls 3,204 ft.

Haskell County: Lewis & Mucher 1 Harley Brown, 27-14-H&TC, 1 mi. SW O'Brien, dry, TD 5,838 ft., elev. 1,585 ft., conglomerate 5,810 ft.

North American Oil Co. 1 L. W. Jones, Coryell CSL, 5 mi. NW Rule, dry, TD 6,121 ft., elev. 1,577 ft., Caddo 5,880 ft., Ellenburger 6,078 ft.

R. N. Ranger 1 W. P. Beckley, ETRR Sur., 14 mi. NE Stamford, dry, TD 5,266 ft., King sand 1,837 ft.

Jack County: Jack Grace 1 W. H. Waller, E. Wray Sur., 8½ mi. NE acksboro, dry, TD 6,386 ft.

S. D. Johnson 1 King, TE&L Sur., 3 mi. E Jermyn, dry, TD 5,058 ft.

T. M. Weatherred 3 Ellis, J. W. Williams Sur., 4 mi. S Antelope, dry, TD 576 ft.

Jones County: A. M. Howsley 1 T. R. Putnam, L. Matthews Sur., 3 mi. SW Leuders, dry, TD 2,075 ft., Valera 535 ft.

Clyde Nelson 1 King, Napoleon Scott Sur., 1 mi. S Lueders, dry, TD 1,900 ft., Gunsight 1,825 ft.

Robinson-Puckett, Inc. 2 C. M. Johnson, 43-15-T&P, dry, TD 2,240 ft.

West Central Drilling Co. 1 Bryan, 19-15-T&P, dry, TD 4,644 ft., elev. 1,615 ft., Flippen 2,260 ft., Hope 2,400 ft.

Palo Pinto County: Ernest Loyd 2 R. H. Gauldin, TE&L Sur., 5½ mi. NW Graford, dry, TD 1,486 ft.

Parker County: Ward & McCullough 1 J. E. Woody, J. Culwell Sur., 4 mi. SW Springtown, dry, TD 3,703 ft.

Stephens County: L. F. Boone & H. L. Martin 1 Jones, 65-6-T&P, 15 mi. SE Breckenridge, dry, TD 2,301 ft.

R. J. Pryer 1 Alvin Mayhall, HT&B Sur., 6 mi. NW Ranger, dry, TD 1,850 ft.

Tidmore Construction Co. 1 Tipton, E. Allard Sur., 18 mi. NE Albany, dry, TD 871 ft.

Young County: Geo. E. Kesterson, Jr. 1 Finch "B," LF&LC Sur., 4½ mi. NW Newcastle, dry, TD 720 ft.

Larson & Thomas 1 A. C. Casey, TE&L Sur., 2½ mi. NE Jean, dry, TD 3,687 ft.

Rocky Mountain

Western Nebraska Discovery Completing in Graneros

DENVER.—Ohio Oil Co. is completing its seventh discovery in the Cheyenne County area of western Nebraska, following recovery of oil at the Johnson area wildcat. The well is in the SE SE SW 35-15n-49w, and oil was found in the three Graneros sands. Total depth is at 4,650 ft. The J sand was topped at 4,566 ft. and oil was found in the top of that formation. Tests in the G sand between 4,495-4,504 ft. recovered 3,770 ft. of green oil in 45 minutes for the best show. The well is 4 miles south of Gurley, first discovery in the current Denver-Julesburg basin area.

At Beaver Lodge, North Dakota, Amerada Petroleum Corp. is cleaning out after re-acidizing the Devonian-Silurian lime section at its 1 Iverson, C SW SW 6-155n-95w, Williams County. The wildcat produced 307 bbl. of oil in 17 hours through ¾-in. choke from 11,630-60 ft., following a 4,000-gal. acid treatment, but dropped to 208 bbl. with 2,000,000 cu. ft. of gas in 24 hours prior to reacidizing. Amerada is experimenting with the well, and may perforate an additional section prior to final completion of the well.

In Wyoming, General Petroleum Corp.'s Tip Top wildcat, on the west side of Green River basin, is perforating and testing the Frontier section prior to completion. The well is 4X-12-G, SW SW NW 12-28n-114w, Sublette County. Frontier was topped at 5,313 ft. Tests through the two Frontier sands have shown some gas but not in volumes expected. The well flowed 100 bbl. of oil per hour from the Nugget sand below 9,682 ft. It opened for exploration a large area in the overthrust belt on the west side of the basin.

COLORADO SUCCESSFUL WILDCAT

Thornberg, Moffat County: Continental Oil Co., 1 Lewin, SE NE SE 17-3n-91w; TD 7,348 ft.; PB 4,326 ft.; flowed 11,200 M.c.f. gas daily; Frontier 1,610 ft., Mowry 1,677 ft., Dakota quartizitic siltstone 1,915 ft., first Dakota sand 2,003 ft., second Dakota sand 2,033 ft., Fuson (?) 2,081 ft., Lakota (?) 2,101 ft., Morrison 2,134 ft., basal Morrison 2,408 ft., Curtis (?) 2,572 ft., Entrada 2,598 ft., Chinle 2,875 ft., Shinarump 3,295 ft., Shinarump porosity 3,330 ft., Moenkopi 3,405 ft., Weber 4,005 ft., Morgan 4,325 ft., gypsum beds 5,300 ft., Madison 7,030 ft.

COLORADO WILDCAT FAILURES

Morgan County: Skelly Oil Co. 1 Scott-Wollever; NE NE SE 30-6n-55w; TD 5,985 ft.; abandoned. Niobrara 4,630 ft., Fort Hays 4,914 ft., Codell 4,953 ft., Carlile 4,957 ft., Greenhorn 5,098 ft., "D" sand (first) 5,399 ft. "J" sand 5,498 ft., Merino pay 5,544 ft., first Lakota 5,739 ft., Morrison 5,854 ft.

Newton Dome, Archuleta County: M. J. Florance 1 Florance-Newton, SW SE NE 5-33n-2w; TD 6,080 ft.; temporarily abandoned. Dakota 2,227 ft., Morrison 2,370 ft., Entrada 3,345 ft.

Padroni, Logan County: Slick-Moorman Oil Co. 1 Ommen, NE NW SW 22-10n-52w; TD 5,301 ft.; abandoned. Niobrara 3,974 ft., Fort Hays 4,197 ft., Greenhorn 4,456 ft., first sand 4,770 ft., "J" sand 4,900 ft., Cloverly 5,084 ft., Morrison 5,288 ft.

Southeast Lee, Morgan County: Orin Tucker et al 1 Peterson, C SW SE 9-2n-56w; TD 6,054 ft.; suspended indefinitely; Muddy (D sand) 5,114 ft., Dakota (J sand) 5,190 ft., Lakota 5,490 ft., Morrison 5,710 ft.

Yuma County: Ben F. Brack 1 Trute, NE SE SE 34-1s-48w; TD 4,030 ft.; abandoned. Niobrara 2,690 ft., Timpas 3,120 ft., Carlile 3,180 ft., Greenhorn 3,340 ft., Graneros 3,390 ft., first sand 3,538 ft., second sand 3,614 ft., Dakota 3,855 ft., Morrison 4,018 ft.

WYOMING WILDCAT FAILURE

West Teapot, Natrona County: Tom Snyder

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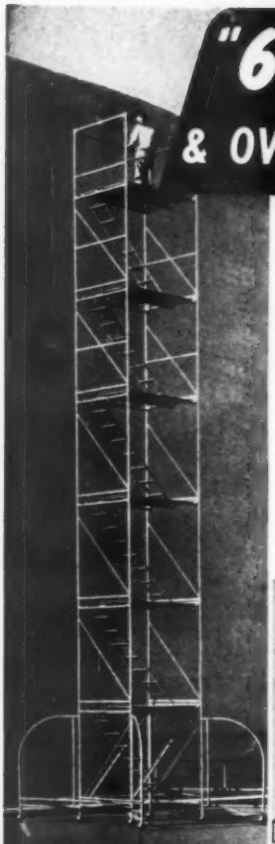

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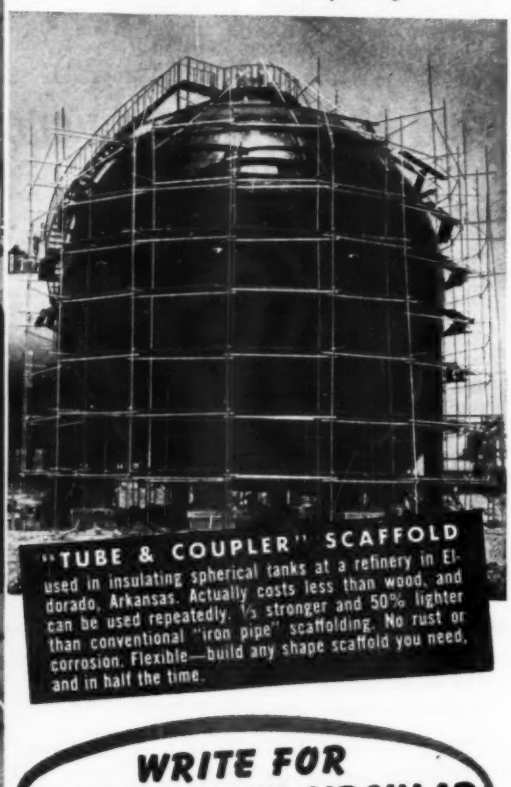

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1 State, NE NE NE 16-38n-78w; TD 1,235 ft.; suspended.

WESTERN NEBRASKA WILDCAT FAILURE

South Potter, Cheyenne County: A. B. Cobb-M. G. Mason 1 Crusader-State; NW NW NW 36-13n-53w; TD 5,936 ft.; abandoned. Niobrara 4,687 ft., Fort Hays 4,962 ft., Codell 5,054 ft., Greenhorn 5,251 ft., first Dakota 5,535 ft., third Dakota 5,648 ft., first Lakota 5,908 ft.

Red Willow County: Indianola 1 McCollum, C SW NW 13-4n-28w, dry, TD 3,616 ft.

Kansas

Trego County Wildcat Indicates Oil Producer

PYRAMID DRILLING CO. got a 3,100-ft. oil fillup when plug was drilled out to test its 1 Schmaker, SE NW SE 26-12-22, prospective pool opener in northwestern Trego County, western Kansas. The well is testing good oil showings encountered in Arbuckle lime topped at 3,961 ft. minus 1,646 ft. Total depth is 3,990 ft. with hole open below 3,966 ft. A drill-stem test of the bottom 18 ft. yielded 1,155 ft. of oil. The location, a mile south of Ogallah, is more than 6 miles from nearest production.

Petroleum, Inc., 1 Lincoln, NW SE SE 29-21-14, a wildcat located 1½ miles west of the Hickman pool, in northwestern Stafford County, recovered 55 ft. of heavily oil-cut mud in a drill-stem test of Arbuckle lime at 3,800-05 ft. Top of the zone was logged at 3,799 ft. minus 1,852 ft. Hole was carried to 3,849 ft. and casing run through the indicated saturation to 3,848 ft.

Another Arbuckle discovery appears to have been made in Rooks County where Francis Oil & Gas Co. 1 Anderson, SW SW SW 9-7-19, filled 90 ft. of clean oil in a 75-minute drill-stem test at 3,400-03 ft. Casing has been run to bottom at 3,403 ft. Location is about a mile southeast of the Locust Grove pool, and about 2½ miles northwest of the Grover pool.

KANSAS SUCCESSFUL WILDCATS

Graham County: Gore 1 Law, NE NE SE 34-9s-23w, pumped 534 bbl. oil per day from Lansing-Kansas City at 3,922-32 ft., TD 4,218 ft., anhydrite 2,025 ft., Topeka 3,550 ft., Heebner 3,703 ft., lime 3,726 ft., cherty Sooy 4,167 ft., Arbuckle 4,203 ft.

Phillips County: B & R 2 Babcock, NW NE NW 27-1s-18w, pumped 2 bbl. oil per day from Lansing at 3,273-77 ft., 3,311-19 ft., and 3,340-63 ft., TD 3,440 ft., Topeka 3,042 ft., Heebner 3,263 ft.

KANSAS WILDCAT FAILURES

Barber County: Sinclair 1 Louise (Moffitt), SW SW SE 5-30s-15w, dry, TD 4,928 ft.

Barton County: Westgate-Greenland 1 Pichner, NE NE NW 23-16s-11w, dry, TD 3,418 ft.

Peel-Hardman 1 Schneweiss, NE NE NE 35-17s-12w, dry, TD 3,420 ft.

Petroleum, Inc. 1 Sullivan, SW NW NW 15-17s-13w, dry, TD 3,365 ft.

Butler County: North American Producing 1 Lauck, SE SE NW 21-27s-3e, dry, TD 3,168 ft.

Cowley County: Lehmann 1 Mahannah, SW SW SE 15-30s-7e, dry, TD 2,875 ft.

Ellis County: Pratt 1 Vine, NW SW NW 14-11s-19w, dry, TD 3,585 ft.

Graham County: Yockey 1 Walker-Russell, NW NW NW 34-9s-22w, dry, TD 4,023 ft.

Brooks Pierce et al 1 Ninemire, NE NE NE 24-9s-23w, dry, TD 4,158 ft.

Marshall County: Ohio 1 Osterkamp, SW SW NE 27-5s-6e, dry, TD 2,565 ft., Howard 935 ft., Topeka 975 ft., Heebner 1,215 ft., Lansing 1,222 ft., Hunton 1,697 ft., Maquoketa 2,170 ft., Viola 2,235 ft., Simpson 2,427 ft., St. Peter 2,483 ft., granite wash 2,532 ft., granite 2,556 ft.

Morris County: Koester & Mergen 1 Wilms, NE NE NW 26-16s-5e, dry, TD 2,312 ft.

Rooks County: Deep Rock 1 Schoiller, NE SE NW 32-7s-19w, dry, TD 3,405 ft.
Deep Rock 1 Hance, SE SE NE 12-8s-19w, dry, TD 3,498 ft.

Russell County: Harms-Knight-Omega 1 Reich, SE SE SW 15-11s-15w, dry, TD 3,350 ft.

Stafford County: Armer 1 Kasselman, SW SW SE 13-21s-12w, dry, TD 3,636 ft.
Imperial 1 Dralle, NE NE NE 16-22s-14w, dry, TD 3,901 ft.
Anschutz 1 Hornbraker, SW SE NW 16-23s-11w, dry, TD 3,795 ft.

Sumner County: Kruse-Porter 1 Murray, SE SE SE 10-30s-2w, dry, TD 3,806 ft.

EASTERN NEBRASKA WILDCAT FAILURE

Richardson County: Richards et al 1 McGill, SE SE NE 9-2n-16e, dry, TD 2,442 ft.

Texas Gulf Coast

Goliad County Discovery Gages Slick, Tests Wilcox

HOUSTON.—Continental Oil Co. has gaged oil production from its new discovery just northwest of Cabeza Creek field, Goliad County, and is continuing to test the Wilcox. The firm's 34 J. E. Pettus, et al, Sesbatiano Vela Survey, flowed 47 bbl. oil per day through perforations in the Slick sand at 7,550-64 ft. Tubing pressure was 1,600 psi., and casing pressure 2,125 psi. The company still has not tested the Mackhank sand which logged oil saturation at 7,728-45 ft.

An excellent show of oil was reported in a sand at 5,123-27½ ft. in Sunray Oil Corp. A-11 McFaddin, wildcat 2 miles north of McFaddin field gas production in Victoria County. Operators drilled the well to total depth of 6,500 ft., ran electric log, and took sidewall samples. The well is now waiting on orders to set casing. It lies in Augustin L. Fernet Grant, Abstract 31.

Superior Oil Co. D-1 Mathilda Tate, north outpost to Altair field, Colorado County, will be completed as an oil and gas well. Operator perforated from 10,741-47 ft., and the well flowed 24 bbl. of oil per day through ¼-in. choke plus 1,274,000 cu. ft. of gas on a 12-hour gage. This test was made in the middle sand. On a 6-hour test of the upper sand, flow was 17 bbl. of 49.3°-gravity oil plus 640,000 cu. ft. of gas through ¼-in. choke.

Potential gage has been run on a new oil-discovery well for the Arneckeville extension area of DeWitt County. The well, Oil Drilling Co. 1 Zengerle Unit 1, flowed 91 bbl. of 36°-gravity oil daily through 8/64-in. choke. Production was through perforations in the Wilcox at 7,656-74 ft. Total depth of the hole is 7,692 ft. with 5½-in. casing set to 7,690 ft. The discovery is located 2,000 ft. southwest of Deep Rock Oil Corp. 1 Nagel, northwest-extension gas producer at Arneckeville field.

TEXAS GULF COAST (DISTRICTS 2 AND 3) SUCCESSFUL WILDCATS

Harlin County: Oil discovery—Sun Oil Co. 1 Dishman-Lucas, Isaac Bridge Sur., Sec. 4, A-132, N flank of Sour Lake dome, TD 11,025 ft., perf. 9,828-43 ft., IP: 196 bbl. oil per day, 8/64-in. choke, 33.7° gravity.

Jackson County: New pay at West Cordell—H. J. Porter, et al, 1 Alma Traylor, F. Adam Sur., A-1, TD 3,310 ft., perf. 2,422-46 ft., IP: completed as gas well, shut in, no gage.

TEXAS GULF COAST (DISTRICTS 2 AND 3) WILDCAT FAILURES

Jackson County: Southern Minerals Corp. A-1 Garland T. Brooking, Josiah H. Bell Sur., A-7, dry, TD 9,046 ft.

Live Oak County: Argo Oil Corp. 2 T. M. Brookshire, I&GN Sur. 15, A-262, dry, TD 5,011 ft.

South Louisiana

Allen Parish Wildcat Tests and Runs Casing

NEW ORLEANS.—Niloco Co. and Bel Oil Corp. apparently have had encouraging shows at their wildcat 2 miles southwest of Reeves in Allen Parish. The wildcat, 1 J. A. Bel, 25-6s-7w, is at total depth of 7,510 ft. Operators ran a drill-stem test of an undisclosed section at that depth, with results unreported, and are running casing.

Shell Oil Co. has recovered fish and is preparing to drill ahead at 1 H. T. Gonsoulin, 41-14s-7e, projected 16,750-ft. test in Weeks Island field, Iberia Parish. The venture is at total depth of 15,641 ft., and operators have been halted by a prolonged fishing job.

In Lafourche Parish, Richardson & Bass, et al, 1-K Lafourche Realty Co., 31-19s-23e, is at total depth of 14,500 ft. and operators are running electric log. The wildcat is cased with 7-in. to 12,838 ft.

SOUTH LOUISIANA WILDCAT FAILURES

Acadia Parish: Alfred Lamson and Sam P. Bennett 1 August Leonards "B," 29-7s-1e, dry, TD 4,508 ft.

Plaquemines Parish: The California Co. 1 Edwin A. Smith, et al, 22-19s-17e, dry, TD 10,500 ft.

Mississippi

Gas-Condensate Completion Extends Wilcox Eastward

JACKSON.—Gulf Refining Co. has completed G-2 Virgil Davis, et al, 7-1n-16w, Wilcox discovery in Baxterville field, Lamar County. Through perforations at 5,182-90 ft., the well flowed 19 bbl. of 57.6°-gravity condensate plus 3,465,000 cu. ft. of gas daily through 22/64-in. choke. Tubing pressure was 2,020 psi. This well is farther east than any yet completed in the Wilcox zone. Nearest production from this zone is located in the fields of southwestern Mississippi lying almost 100 miles to the west.

Union Producing Co.-Jones-O'Brien 1 Logan, 23-10n-32, Smackover test on the west side of Tinsley field, Yazoo County, is conditioning mud and preparing to cut and pull drill pipe. Operators backed off drill pipe at 4,610 ft. The amount of gas in the mud gradually diminished and finally cleared up, so that operators now feel fairly certain this gas was coming from a sand up the hole rather than from the Smackover at 14,167 ft. The well blew out while coring at that depth and blew sour gas and mud for 48 hours before it was killed. During the past week, operators have changed drilling mud from oil emulsion to starch and lime base.

Final completion on Jon Brooks, Jr.-Petersen Drilling Co. 1 Louis Wax, 36-3n-3w, discovery well for North Lessley field, Wilkinson County, has been delayed until pumping equipment can be installed. After iinstalling separator and tanks, the well flowed 70 bbl. of oil the first 12 hours through 7/32-in. choke with tubing pressure 65 psi. The next 24 hours, the well flowed 85 bbl. of 32.8°-gravity oil through same choke with tubing pressure fluctuating between 50 and 70 psi. Shortly thereafter, the well died. Swab was run for 4½ hours, but well would not flow.

MISSISSIPPI WILDCAT FAILURES

Adams County: Humble Oil & Refining Co. B-1 Laura Butler, 15-5n-3w, dry, TD 7,000 ft.

Adams County: Wheless Drilling Co. 1 El-

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eanor Williams, 39-8n-2w, dry, TD 10,128 ft.

Jefferson County: Gulmon & Jones-Lyle Cashion Co. 1 Gordon Stowers, 43-9n-1w, dry, TD 6,005 ft.

Oklahoma

Oil Showing Passed Up In Woodward Wildcat

SINCLAIR OIL & GAS CO. has passed up for the time being promising oil and gas showings in Viola lime and Simpson dolomite at its 1 O. Z. Morrow Community, C SE SE 6-23n-19w, deep wildcat test 7 miles northeast of Woodward, Woodward County, in the northwestern part of the state. At latest report it was coring ahead and nearing the expected level of the Wilcox zone.

This well, located on the northward trend of the Anadarko Basin and far removed from any other production, created considerable interest early the past week when it flowed clean oil at estimated rates of 10 to 11 bbl. per hour in a drill-stem test. Importance of the discovery was not belittled, but some of the edge was taken off the interest when a substantial volume of water showed up as the testing tool was pulled. The recovery in the breakdown was 3,870 ft. of oil and water (30 per cent water), and 1,260 ft. of clear water. The test, with tool open 46 minutes, was of an interval at 9,679-9,715 ft., embracing the lower part of the Viola lime (top 9,560 ft.) and the upper part of the Simpson dolomite (top 9,695 ft.).

A second test of the same section at 9,683-9,715 ft. with tool open 230 minutes started gassing in 15 minutes, flowed oil-cut mud in 69 minutes, and, after returning the water load, flowed 22 bbl. of fluid (50 per cent oil) in 1½ hours. Flow was through ½-in. bottom-hole and ⅝-in. top-hole chokes. Recovery in the breakdown was 4,630 ft. of fluid (42 per cent 44°-gravity oil) and 2,340 ft. of water.

Shell Oil Co. has encountered another promising pay zone, the second, in its 1 Tugman, NE SW NE 11-2n-8w, a wildcat located 2 miles west of Marlow, in northwestern Stephens County. A 75-minute drill-stem test of the zone, taking in an interval at 6,629-74 ft., had gas at the surface within 9 minutes, and started flowing oil when pipe was being pulled, unloading 6,300 ft. of oil and gas. Recovery at the end was 300 ft. of oil. The well previously had shown for a good producer in a Pennsylvanian sand at 6,078-6,112 ft., where, in a drill-stem test, it flowed oil at an estimated rate of 20 bbl. per hour.

Republic Natural Gas Co. has opened a new pay zone, the Misener sand, for Ingalls pool, Payne County, where its 1 Berry, NW SE SW 22-19n-4e, flowed 15 bbl. of 42°-gravity oil in 24 hours through 13/64-in. choke. Misener is open through casing perforations at 3,831-36 ft. Location is on the north flank of the pool.

OKLAHOMA SUCCESSFUL WILDCATS

Beckham County: Extension to Elk City—Northern Ordnance and United Carbon 1 W. T. Music, C SW NW 26-10n-21w, flowed 552 bbl. 48°-gravity oil per day from 10,051-63 ft. and 10,450-80 ft., TD 10,526 ft.

Carter County: Geological test in Sholem Alechem—Gulf 8 Lyles, SW SE NE 3-2s-3w, pumped 91 bbl. 31.3°-gravity oil per day from sands at 3,060-3,174 ft., TD 6,306 ft., Springer 3,770 ft., Markham 3,860 ft., Aldridge 4,250 ft., Humphrey 4,926 ft., Simpson 5,466 ft., Goodwin 6,092 ft.

Stephens County: Stephens Petroleum 1 McManus, NE NW SW 30-1n-5w, pumped 5 bbl. 37°-gravity oil per day from sand and shaly sand at 698-744 ft., TD 3,500 ft., limy sand 809 ft., Deese (?) 1,762 ft., lime and chert 3,357 ft., conglomerate lime 3,463 ft.

OKLAHOMA WILDCAT FAILURES

Carter County: Durham 1 Hall, NW NE NE 4-5s-2e, dry, TD 540 ft.

Terminal Land 1 Carter, NW NW SE 5-1s-2w, dry, TD 1,369 ft.

Geological test in Fox-Graham—Jackson & Shear 1 Croate, NE NE NW 36-2s-3w, dry, TD 5,014 ft., base oolitic-top Deese 2,732 ft., fusilinid 3,849 ft., Tussy lime 4,438 ft.

Comanche County: Atlantic Refining 1 Kuntz, NE NE SE 21-4n-11w, dry, TD 2,488 ft., iVola 805 ft., Sylvan 1,000 ft., Hunton 1,100 ft., Woodford 1,255 ft., Hunton 1,643 ft., Sylvan 2,255 ft.

Cotton County: Strother & Strother 1 Zweiaker, NW SE NE 20-3s-12w, dry, TD 1,940 ft.

Blair 1-A Jensen, S/2 SE NW 21-4s-10w, dry, TD 1,550 ft.

Ross 1 Pau-Kau-Brhce, NW NW NE 2-5s-13w, dry, TD 1,908 ft.

Haskell County: Leflore County Oil & Gas 1 Cowlington (Wood?), S/2 NE 36-10n-23e, dry, TD 3,026 ft., Keota sand 280 ft., Stigler coal 565 ft., Cameron sand 567 ft., Leguire-Warner sand 805 ft., Hartshorne sand 1,215 ft., Atoka 1,340 ft., and 2,357 ft., shale 2,655 ft., sand 2,678 ft. and 2,916 ft.

Kay County: Mazda Oil 1 Tarpenning, SE SE NE 30-28n-2e, dry, TD 3,771 ft., Tonkawa 2,423 ft., Layton 2,849 (?) ft., Oswego 3,282 ft., Skinner 3,520 ft., Red Fork 3,596 ft., Inola 3,675 ft., Missisppi chert 3,729 ft.

Sunray 1 Glenny, NW SE SW 20-28s-1w, dry, TD 3,664 ft., Pawhuska 1,685 ft., Oread 2,010 ft., Lovell 2,193 ft., Tonkawa lime 2,335 ft., Tonkawa sand 2,395 ft., Layton 2,805 ft., Checkerboard 3,090 ft., conglomerate 3,133 ft., Oswego 3,203 ft., Mississippi lime 3,440 ft., Woodford 3,454 ft., Simpson dolomite 3,487 ft.,

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Kingfisher County: National Associated Petroleum 1 Hickey "A," NW NW NW 33-19n-5w, dry, TD 7,198 ft., Checkerboard 5,566 ft., conglomerate 5,655 ft., Oswego 5,774 ft., Mississippi lime 6,178 ft., Woodford 6,720 ft., Sylvan 6,822 ft., Viola 6,880 ft., Marshall 7,076 ft., second Wilcox 7,168 ft.

Lincoln County: Scat Drilling and R. L. Kemp 1 School Land Tract 15, NW NW SE 16-16n-4e, dry, TD 4,679 ft.

Logan County: Harper-Turner 1 Murphy, SE SE NE 17-19n-4w, dry, TD 5,781 ft.

Love County: Sohio 1 Bourland, NE NE SE 2-6s-1e, dry, TD 1,369 ft.

Murray County: Larson 1 Wheeler, NE NE SW 19-1n-4e, dry, TD 540 ft., sand 340 ft.

Payne County: Bay Petroleum 1 Steincamp, SW SW SE 29-19n-4e, dry, TD 4,170 ft.

Pittsburg County: Portman 1 Southard, C SW NE 34-6n-15e, dry, TD 1,230 ft., sand 620 ft., 1,000 ft., and 1,030 ft., shale 1,215 ft.

Pontotoc County: Halliburton 1 Shields, NE SE NW 2-3n-6e, dry, TD 4,542 ft.

Watkins 1 Golden, SW SW SE 16-4n-5e, dry, TD 1,208 ft.

Seminole County: Keener Oil & Gas 1 Jackson "D," NE NE SE 16-7n-7e, dry, TD 2,221 ft.

Deardorf 1 Trimble, NW NE NW 29-8n-7e, dry, TD 4,298 ft.

Appalachian-Ohio

South Penn Brings in Good Gasser in West Virginia

PITTSBURGH.—In Poca district, Putnam County, West Virginia, South Penn Oil Co. 4 Frank A. Hardy, et al., elevation 823 ft., completed for 5,179,000 cu. ft. of gas after shot, with a rock pressure of 1,170 psi. in 39 hours, Corniferous lime was logged at 4,818 ft.; Oriskany sand at 4,902 ft.; gas at 4,909 ft. Total depth was 4,926 ft.

In Tucker district, Wirt County, Louis E. Reed 1 Earl Tanner, wildcat, elevation 1,050 ft., was completed for 84,000 cu. ft. of gas after shot. Rock pressure was 1,750 psi. in 72 hours. Corniferous lime was logged at 5,580 ft.; Oriskany sand from 5,789-5,816 ft.; gas from 5,793-95 ft. Total depth was 5,855 ft. This well is on the Elizabeth Quadrangle and is not a part of the Limestone Hill section developed to the west on the Belleville Quadrangle.

In Garrett County, Maryland, Western Maryland Gas Co. 1 George Dawson (Lots), elevation 2,451 ft., topped the Oriskany sand at 3,487 ft. and is at a depth of 3,488 ft. with gas gaging 9,500,000 cu. ft.

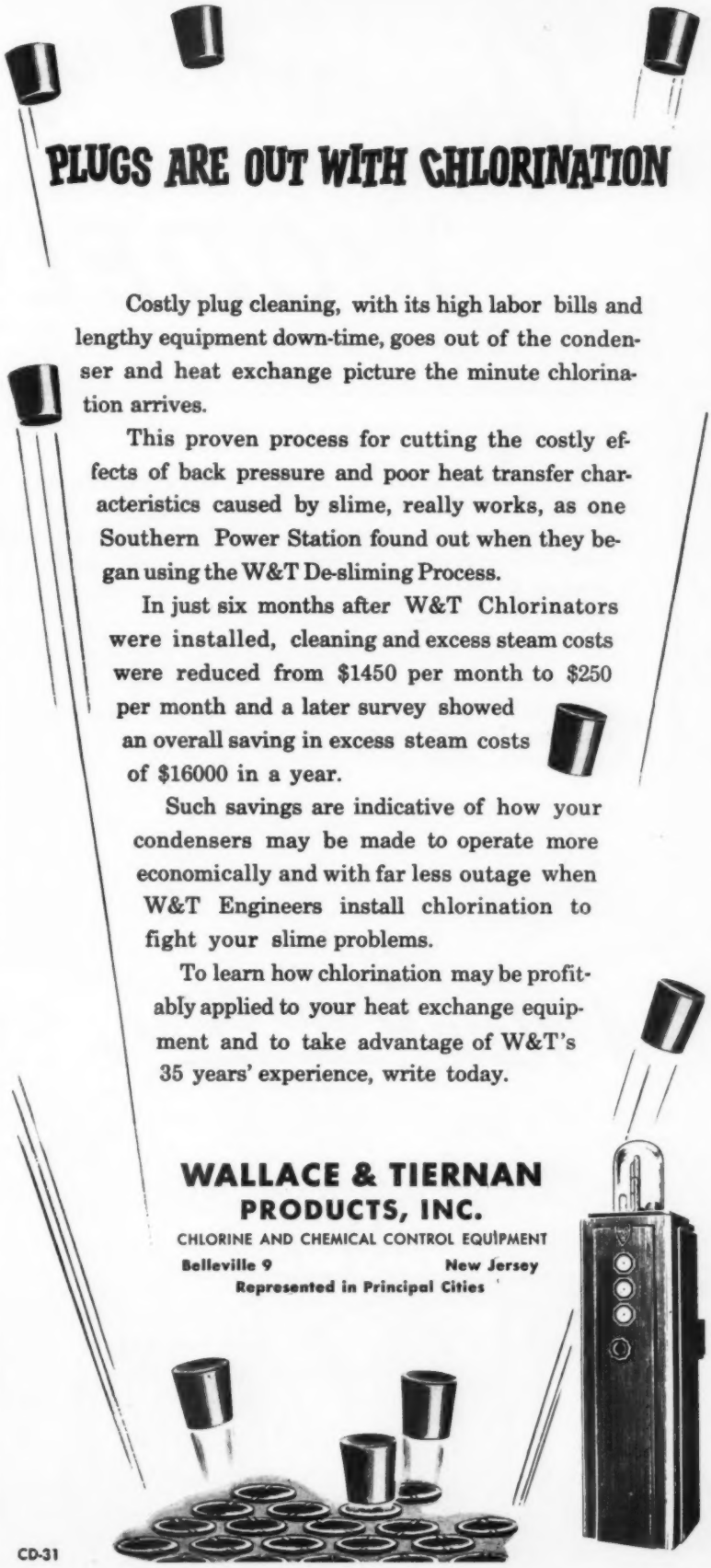
WEST VIRGINIA SUCCESSFUL WILDCAT

Wirt County: Louis E. Reed 1 Earl Tanner, elev. 1,050 ft., completed for 84,000 cu. ft. of gas after shot in Oriskany sand; rock pressure 1,750 psi. in 72 hours, TD 5,855 ft.

OHIO

COLUMBUS.—Allen Willey et al. drilled in their 1 Forest Taylor, Lot 26, Clark Township, Coshocton County, with a good show of oil in the first Clinton, logged at 3,508-41 ft. The second Clinton at 3,548-68 ft. was dry. After shooting with 140 qt., the well flowed 130 bbl. oil in 24 hours with 250,000 cu. ft. gas. The producer is a ⅛-mile extension to Layland pool.

In Jackson Township, Knox County, Wray Drilling 1 W. C. Taylor, Section 8, made 30 bbl. oil in 24 hours after an 80-qt. shot. Clinton sand was reported at 2,937-80 ft. In Section 1, C. A. Davis 3 George Rine gaged 100,000 cu. ft. gas with a small show of oil, natural, from sand at 3,112-63 ft. After shooting with 30 qt., it made an estimated 200,000 cu. ft. of gas.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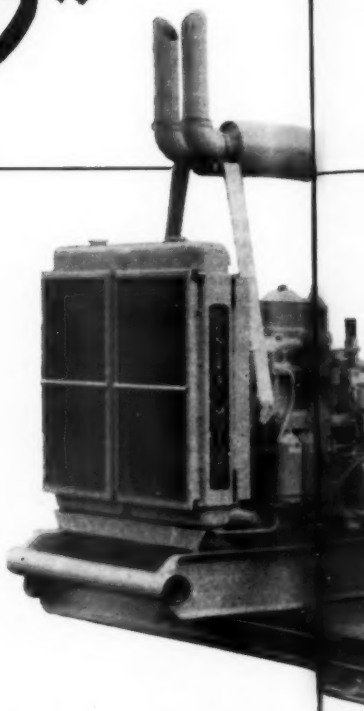

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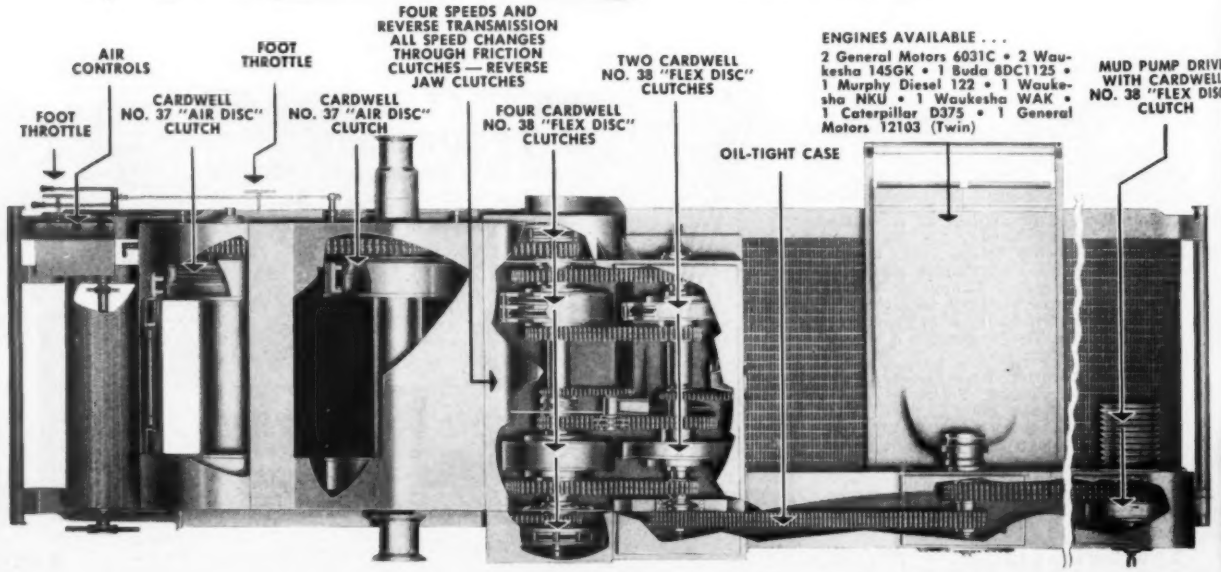
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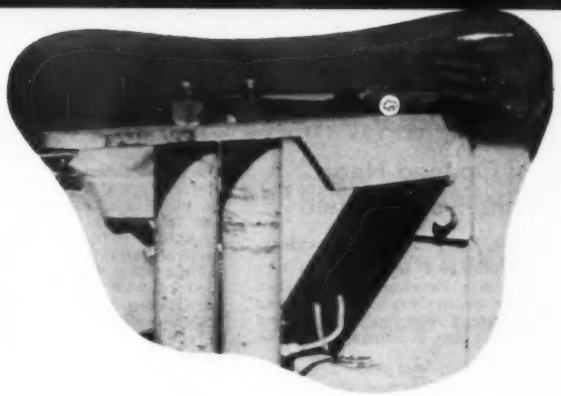

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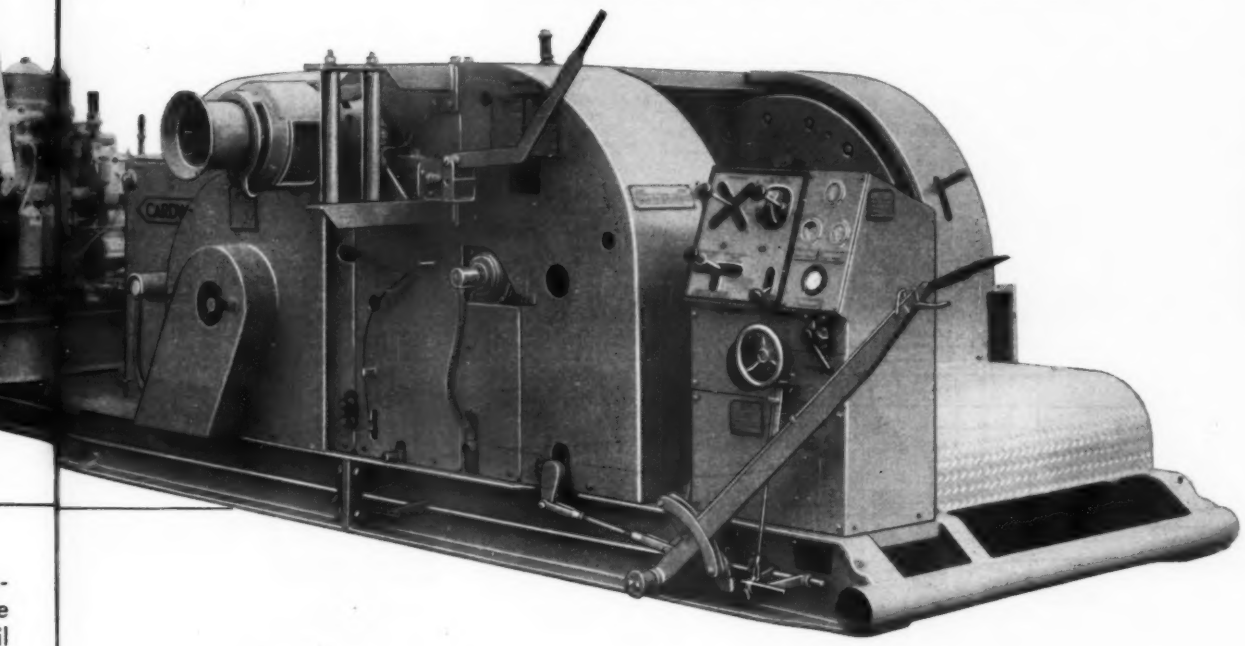

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Permian Basin

New Pool Opened Near Parks Pennsylvanian Field

MIDLAND.—A big Pennsylvanian discovery was completed this week, a new reef discovery was developing in Borden County, another Pennsylvanian wildcat had further oil in the Fusselman section, and a Spraberry strike was in prospect in Dawson County.

The completed well was The Texas Co. 1-B Scharbauer which flowed 660 bbl. of 55°-gravity oil in 24 hours through 24/64-in choke. The 3-mile outpost to the Parks Pennsylvanian field, or new pool opener, produced from open-hole section from 10,345-10,470 ft. and perforations from 10,290-10,325 ft.

Vickers Petroleum Co. 1 McKnight, Borden County wildcat, reported clean oil from top of the Pennsylvanian limestone, tentatively identified as reef, on a drill-stem test from 7,735-60 ft. The well did not flow but started unloading when one stand of pipe had been pulled. It continued to unload clean oil down to the last five stands, which had some water. Electrical surveys were being run.

According to field sources, data on the 1 McKnight had not been confirmed by operators. Top of the reef was placed at 7,735 ft., on elevation of 2,469 ft. Location is 13 miles east of Gail in 367-97-H&TC.

In Martin County, Gulf Oil Co. 2-EB Glass, which had flowed some 30 bbl. of oil in 5 hours from the Pennsylvanian at 10,400-10,582 ft., had oil on a 2-hour drill-stem test of the Fusselman section between 12,100-65 ft. Recovery was 510 ft. of fluid, of which the top 380 ft. was oil and gas-cut mud and the remaining 150 ft. 44°-gravity oil. It was coring ahead following the test. Location is a northeast offset to Gulf's 1-EB Glass, which had discovery production in the lower Spraberry.

In east-central Dawson County, James H. Snowden and others had shows of oil on a drill-stem test at their 1-43 Dean. Location is 12 miles northeast of Lamesa and 2½ miles southeast of the same operators' 1-32 Dean. The test was run from 7,525-80 ft., with tool open 9 hours and 15 minutes. Recovery was 720 ft. of oil and gas-cut drilling mud with no water. It was deepened to 7,639 ft. where electrical surveys were being run.

Snowden's 1-32 Dean was reported ready to complete as a pumper, having made around 45 bbl. of oil on a 24-hour test from perforations in Spraberry sand from 7,394-7,406 and 7,411-17 ft.

WEST TEXAS (DISTRICTS 8 AND 7-C) SUCCESSFUL WILDCATS

Glasscock County: Allison Production Co. 2 Judkins-Walton, 43-36-3S-T&P, TD 7,027 ft., elev. 2,625 ft., Spraberry 6,918 ft., IP flowed 803 bbl. 38°-gravity oil a day, ½-in. choke, GOR 720 cu. ft., TP 125 psi.

Runnels County: Humble Oil & Refining Co. 1 Roy Tyree, B. E. Hall Sur., 5½ mi. W Hatchell, TD 5,281 ft., Ellenburger 4,577 ft., IP pumped 19 bbl. 50°-gravity oil a day.

Upton County: Cities Service and Continental Oil Co. 1 University AH, 29-3-University, TD 11,281 ft., elev. 2,752 ft., Ellenburger 10,723 ft., perf. 10,855-876 ft., IP flowed 2,044 bbl. 60°-gravity oil a day, ¾-in. choke, TP 425-575 psi., GOR 1,658 cu. ft.

WEST TEXAS (DISTRICTS 8 AND 7-C) WILDCAT FAILURES

Coke County: Mizel Bros. 1 M. L. Leddy, 11-Z-D&SE, 12 mi. SW Robert Lee, dry, TD 6,908 ft., elev. 2,486 ft., Strawn 6,661 ft.

Conchoe County: Skelly Oil Co. 1 H. E. McCulloch, T. J. Caswell Sur., 5½ mi. NE Millersview, dry, TD 3,097 ft., elev. 1,611 ft., Caddo 2,706 ft., Marble Falls 2,730 ft., Ellenburger 2,847 ft.

Watts & Hays 1 Dodson, German Emigration Sur. 118, 3 mi. W Paint Rock, dry, TD 4,124 ft., elev. 1,629 ft., Strawn 3,510 ft., Ellenburger 3,998 ft.

Hockley County: Geo. P. Livermore, Inc. 1 C. R. Wood, 58-A-R. M. Thompson Sur., dry, TD 9,671 ft., elev. 3,415 ft., Glorietta 5,120 ft., Pennsylvanian 9,615 ft.

Howard County: Sunray Oil Co. 1-A Noel Lester, 27-33-3N-T&P, dry, TD 8,800 ft., elev. 2,740 ft., Spraberry 6,525 ft., reef 8,677 ft.

Kent County: Sun Oil Co. 1-B Wallace, 43-98-H&TC, dry, TD 7,118 ft., elev. 2,012 ft., Ellenburger 7,090 ft.

King County: Southern Minerals Corp. 1 Moorhouse, J. Fullingham Sur., dry, TD 5,929 ft., Cisco 3,490 ft., Canyon 4,060 ft.

Lynn County: Mid-Continent Petroleum Corp. 1 W. T. Cook, 517-1-GC&SF, dry, TD 9,736 ft., elev. 3,051 ft., Spraberry 6,030 ft., Pennsylvanian 8,880 ft., Ellenburger 9,683 ft.

Pecos County: Hunt Oil Co. 26 Elsinore Royalty, 35-D-GC&SF, dry, TD 1,516 ft. R. B. Rawlins 1 A. R. Johnson, 12-10-H&GN, dry, TD 1,044 ft.

Runnels County: Cabot Carbon Co. 1 Alexander, J. H. Miquel Sur. 72, 1 mi. W Crews, dry, TD 4,068 ft., elev. 1,904 ft., Capps 3,482 ft., Gardner 3,905 ft., Gray 4,025 ft.

Creslenn Oil Co. 1 J. S. Tucker, J. Lewis Sur., 5 mi. SE Winters, dry, TD 4,350 ft., Capps 3,632 ft., Gardner 4,005 ft., Caddo 4,225 ft.

Schleicher County: Hiawatha Oil & Gas Co. 2 Runge, 66-M-GH&SA, 3 mi. NE Halldale, dry, TD 6,400 ft., elev. 2,168 ft., Strawn 5,623 ft., Ellenburger 6,360 ft.

TEXAS PANHANDLE (DISTRICT 10) WILDCAT FAILURE

Hall County: Honolulu Oil Corp. 1 Noel, T. A. Thompson Sur., 7 mi. SW Memphis, dry, TD 3,070 ft. in Permian.

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SOUTHEASTERN NEW MEXICO

HOBBS.—Magnolia Petroleum Co. 1 J. B. Brown, Roosevelt County discovery in 6-7s-34e, prepared to set casing on bottom at 8,273 ft. for completion attempt in the Permo-Pennsylvanian. A 2-hour test from 8,088-8,142 ft. flowed 112 bbl. of oil. Core from 8,260-73 ft. recovered 13 ft. of limestone. 1 ft. showing slight fluorescence. A test from 8,210-60 ft. had gas and recovered oil and gas-cut mud with some sulfur water.

Sharples Oil Co. 1 Seth Alston, Lea County wildcat, ran a 3-hour drill-stem test in the basal Pennsylvanian from 12,752-828 ft. Gas surfaced in 44 minutes and was estimated at 210,000 cu. ft. daily. Recovery was 560 ft. of fluid slightly cut with gas It was drilling ahead.

SOUTHEAST NEW MEXICO SUCCESSFUL WILDCAT

Lea County: Lawton Oil Co. and W. L. Goldston 1-A State, 30-15s-33e, TD 10,621 ft., elev. 4,225 ft., Pennsylvanian 10,212 ft., pay 10,587 ft., IP flowed 336 bbl. 42°-gravity oil in 24 hr., ¼-in. choke, TP 150 psi.

SOUTHEAST NEW MEXICO WILDCAT FAILURES

Chaves County: Magnolia Petroleum Co. 2 Black Hills Unit, 31-17s-20e, dry, TD 5,160 ft., elev. 4,959 ft., Permo-Pennsylvanian 4,260 ft., Mississippian 4,561 ft., Devonian 4,789 ft.

Eddy County: Carper Drilling Co. 1 Quillen, 12-19s-31e, dry, TD 4,284 ft., elev. 3,629 ft., Yates 2,592 ft., Queen 3,512 ft.

California

Testing Under Way at Cuyama Valley Wildcat

LOS ANGELES.—Testing was under way at a Cuyama Valley wildcat, located about 3½ miles northeast of South Cuyama field, after 7-in. casing had been set at 7,490 ft. The valley's latest prospect, a joint test of Seaboard Oil Co. and Richfield Oil Corp., was attempting to establish production from a zone stratigraphically higher than the Dibblee and Hibberd sands produced at South Cuyama.

The wildcat, No. 1 Seaboard-Richfield-Kirschenmann in SE Section 22-10n-26w, had been drilled to a total depth of 10,097 ft. Electric logs and side-wall samples at the shallower depth apparently showed sufficient promise to warrant plugging back and running casing. The well is located about 1 mile north of a dry hole, No. 1 Perkins, drilled by Richfield last year to a depth of 11,883 ft.

Further east in the valley, Richfield was drilling and spot coring below 10,000 ft. at No. A-1 Mettler in Section 13-10n-25w. In Section 10-10n-26w, 2 miles north of the Kirschenmann test, Richfield was reported taking side-wall samples at 11,411 ft. in its No. C-2 Russell.

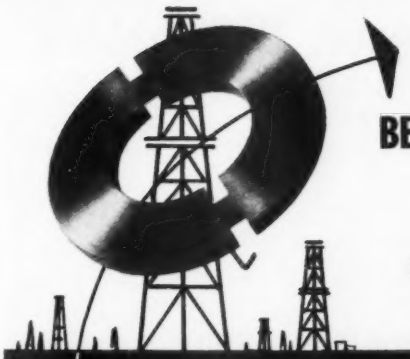
A highly regarded area in Kings County, in the McClure Valley south of Pyramid Hills, has another test under way. It is the Mitchell Co. No. 1 Mitchel-Martin in Section 20-24s-18e, a test scheduled to go to 1,500 ft. It is located about 2,600 ft. west of a dry Tide Water wildcat which topped the Kreyenhagen at 1,200 ft. and the Cretaceous at 2,375 ft. About 1,400 ft. west of the new test, a wildcat drilled by General Petroleum Corp. went through a fault zone at 1,500-2,000 ft. before being abandoned at 2,077 ft.

CALIFORNIA UNSUCCESSFUL WILDCATS

Kern County, south Gosford area: General Petroleum Corp. 41-25 Coulter, 25-30s-26e, dry, TD 8,375 ft., elev. 350 ft.

Kings County, north Pyramid Hills area: T. M. Pope 1 Eagle, 8-24s-18e, dry, TD 1,850 ft., elev. 845 ft.

Los Angeles County, Bandini area: Los



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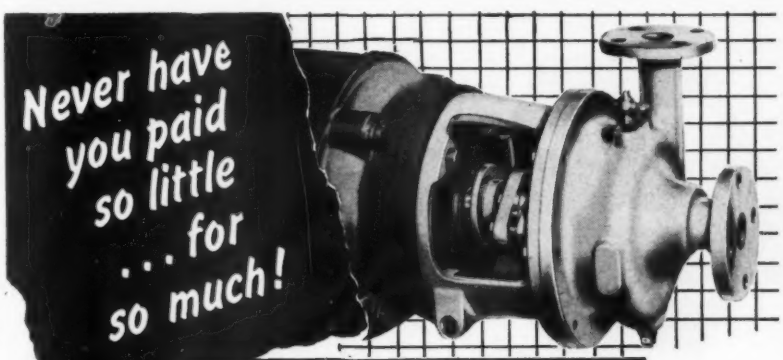

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Nietos Co. 1 Los Nietos-C.C.M.O., 18-2s-12w, dry, TD 9,320 ft., elev. unknown. Inglewood area: Standard Oil Co. of Calif. 2-18 Vickers, 7-2s-14w, dry, TD 9,268 ft., elev. 100 ft.

Oak Canyon area: Humble Oil & Refining Co. B-1 Newhall Land, 12-4n-17w, dry, TD 12,744 ft., elev. 1,007 ft.

San Luis Obispo County, Cuyama Valley area: Richfield Oil Corp. A-4 DeKoch, 24-11n-29w, dry, TD 3,073 ft., elev. 1,728 ft.

Ventura County, Quatal Canyon area: Richfield Oil Co. 2 Gillbergh-A, 24-9n-24w, dry, TD 3,335 ft., elev. 3,849 ft.

Canadian Fields

Offset to Discovery Tests Gas and Oil

CALGARY. — Midland Petroleums, Ltd., Vancouver independent, found some oil plus a large flow of natural gas in the top of the Lower Cretaceous at its Ellerslie area venture, and is coring and testing. Location is on an 80-acre farmout from Imperial Oil, Ltd., offsetting the Ellerslie Cretaceous oil discovery. The well, Midland-Meek 1, topped the basal quartz sand at 3,862 ft., 11 ft. higher than the discovery well. Initial drill-stem test in that section, from 3,862-67 ft., gave a recovery of 40 ft. of oil-cut mud in 1 hour. Second test, from 3,867-91 ft., had a natural gas flow rate of 3,700,000 cu. ft. daily plus an oil spray. Latest test was run at 3,900-07 ft., with maximum natural gas flow rate measured at 3,930,000 cu. ft. daily. Recovery during 1 hour was 90 ft. of gassy oil, no water. Hole has since been cored to 3,912 ft., and crew is preparing to run a fourth Cretaceous drill-stem test. The Midland 1 is spotted in LSD 7, 31-51-24w4, ¼ mile south of C.P.R.L.-Ellerslie 1 oil discovery.

Three American oil firms carrying out an extensive exploratory program in Alberta have struck natural gas at a joint wildcat being drilled in the Wimborne area about 35 miles west-southwest of Big Valley oil field and 62 miles north-northeast of Calgary. The well is being drilled by Socony-Vacuum Exploration Co., Canadian Gulf Oil Co., and Amerada Petroleum Corp. The Wimborne 1, in LSD 15, 11-34-26w4, ran 40-minute drill-stem test from 7,310-75 ft. A flow of gas hit the surface 7 minutes after valve was opened, with flow rate estimated from 500,000 to maximum 1,000,000 cu. ft. daily. Pipe recovery was 570 ft. of black sulfur water. Drilling below 7,505 ft., the well is scheduled as a test through the Devonian into the Waterways horizon, around 8,000 ft.

Canadian Gulf Oil Co. has staked location for a 2½-mile southwest extension to its Big Valley Devonian oil field in the southern sector of Alberta. Big Valley, located about 80 miles northeast of Calgary, was chalked up as an oil discovery in both the D2 and D3 zones of Devonian last September. To date the company has successfully completed six oil wells in that pool. The extension effort will be Gulf-Brockel 8, in LSD 8, 30-34-20w4, about 2½ miles southwest of Gulf's 12 producer.

Spring Coulee Petroleums, Ltd., had a small showing of gas plus some oil staining at its joint Spring Coulee venture with National Petroleum Corp., Ltd. The show, in the Milk River-Colorado transition zone, did not warrant testing, and crew is now drilling ahead for its lower objectives. The well, National-Spring Coulee 1, in LSD 10, 11-4-23w4, is located about 2 miles northwest of National-Spring Coulee-Malmberg 1, oil discovery 4 miles south of Spring Coulee town. The gas shows and oil staining were found in drilled and cored sections from 3,112-21 ft. Previous wells in the area, both the Alberta and Montana sides, had shown some natural gas in small volume in that horizon.

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Michigan

Sherman Township Wildcat Testing in Dundee Dolomite

MOUNT PLEASANT.—Acid treatment was scheduled for Mogul Oil Co.'s 1 Hammar, SW SW NE 20-20n-9w, Sherman Township wildcat in Osceola County, this week. The wildcat has been flowing and swabbing an average of 50 bbl. of oil a day natural from a Dundee dolomite pay since cement plug was drilled and hole cleaned out. Dundee top was logged at 3,861 ft. Hole was deepened 2 ft. while being cleaned out, and total depth now is 3,872 ft. Pay section as indicated in core and samples was from 3,862-72 ft.

Basin Oil Co.'s 2 Kartes, SW SE NW 15-21n-1e, Edwards Township, Ogemaw County, diagonal northwest 20-acre offset to the Edwards field discovery well, and the first followup test in the field, was dry in the Dundee at 3,377 ft., total depth.

Production from Gulf Refining Co. 1 Ruckel, NE SW NW 18-14n-18w, Shelby field discovery well, Benona Township, Oceana County, will be restricted to 75 bbl. of oil a day, pumping. Bottom-hole water broke in after 3 days of pump tests following plug-back acid treatment in Traverse.

MICHIGAN SUCCESSFUL WILDCAT

Oceana County, Benona Township: Gulf Refining Co. 1 Ruckel, NE SW NW 18-14n-18w, Traverse 1,732 ft., 75 bbl. pinched, TD 1,763 ft., PBTD 1,759 ft.

MICHIGAN WILDCAT FAILURES

Kalamazoo County, Comstock Township: Ford Oil Co. 1 Campbell, NW NW SE 4-2s-10w, Traverse 1,443 ft., dry, TD 1,473 ft.

Kent County, Solon Township: James J. McGerry, Trustee 1 Heis, SW SW SW 9-10n-11w, Traverse 2,506 ft., dry, TD 2,622 ft.

Livingston County, Unadilla Township: Verne D. Hook 1 McClear, SW NW SW 28-1n-3e, Dundee 1,604 ft., dry, TD 1,684 ft.

Van Buren County, Almena Township: S. Scott Wigle 1 Stoughton, NE NW NW 8-2n-13w, Traverse 1,298 ft., dry, TD 1,323 ft.

Eastern Texas

Anderson County Wildcat Completed in Rodessa

DALLAS.—Continental Oil Co. has a prolific gas-distillate discovery at its 1 Frank H. Carroll, Anderson County wildcat 5 miles south-southwest of Tennessee Colony and about 500 ft. from the old Trinity River bed.

Completion was from the Rodessa limestone through perforations at 8,796-8,806 ft. Calculated open-flow potential was 90,000,000 cu. ft. of gas a day, plus 65 bbl. of 56°-gravity oil per 1,000,000 cu. ft.

Completion of a Pettit limestone gas-distillate discovery in Harrison County, 7 miles southeast of Hallsville, was expected. The well is Skeeters and Curry Drilling Co.'s 1 W. T. Cook, J. R. Davis Survey. Operators had pipe set on bottom at 6,800 ft. and were waiting on cement. A test in the lime from 6,672-92 ft., open 15 minutes, recovered 100 ft. of mud heavily cut with gas and distillate. Bottom-hole flowing pressure was 770 psi. and shut-in pressure reached 3,360 psi.

In Rains County R. J. Caraway 1 H. L. Puckett, deep discovery southeast of Emory, was trying to kill the flow of gas and distillate to install a new control head. On its last gage the well was averaging 4 bbl. of distillate an hour with gas volume of 2,900,000 cu. ft. daily. Pay section was between 11,958-12,126 ft., which was believed to be the Smackover. According to reports, hydrogen sulfide content of the gas was 42 per cent.

Hollandsworth Oil Co. 3 Frank Davis, in the Woodlawn gas-distillate field of Harrison County, was ready to complete as the field's first oil producer. A 6-hour test through ¼-in. choke, averaged 22.5 bbl. of 41°-gravity oil an hour. Production was from the upper Pettit at 6,467-77 ft. Completion test was held up for additional storage.

Louisiana-Arkansas

Red River Wildcat Undergoing Tests

SHREVEPORT.—A rank wildcat in Red River Parish is being tested by Inland Oil Co. Operator has drilled to 2,623 ft., and run 5½-in. casing to 2,625 ft., at the 1 Saucier in Section 19-14n-10w. This is the second exploratory venture by the company in this area. The first well, 1 Pierson, in the same section, was dry at 2,908 ft.

In LaSalle Parish, J. S. Michael Co. has started drilling at a new Wilcox test, C-2 Nebo Oil Co. in Section 9-6n-3e. The well is ¾ mile south of the same company's C-1 Nebo, which is still testing, and approximately 2 miles west of Catahoula Lake.

Arkansas.—Atlantic Refining Co. has staked a west offset to the Smackover discovery in East Schuler field, Union County. The 2 Bishop is located in Section 13-18s-17w, west of Kinard 1 Burns which opened Smackover production in the field. Production at the Burns is from an interval

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below 7,610 ft. Proposed depth for the new test is 7,800 ft.

In Miller County, Skelly Oil Co. will drill a northwest diagonal offset to its recent discovery, 1 Heilbron. The B-1 Durham is staked in 21-16s-26w, and proposed depth is 4,280 ft., sufficient to test the pay horizon of the discovery as well as producing zones in Fouke field.

NORTH LOUISIANA WILDCAT FAILURE

Caddo Parish: Loyd & Langston et al 1 Doles, 75 ft. N and 1,270 ft. W SEc 32-33n-14w, dry, TD 1,691 ft.

ARKANSAS WILDCAT FAILURE

Ouachita County: Davis & Whaley 1 Elliott, SE NE NE 16-15s-17w, dry, TD 3,499 ft.

Illinois-Ind.-Ky.

Edwards County Wildcat Shows Oil in Two Zones

WAYNE MISENER and W. F. Lacy have encountered good saturation in both the Rosiclare and McClosky zones at their 1 Bower, a wildcat located in the SE SE NE 5-2s-10e, about 3 miles west of Albion, Edwards County, Illinois. No drill-stem test was made of the McClosky saturation, logged at 3,365-72 ft. and 3,384-88 ft., but in a test of the Rosiclare at 3,344-58 ft., the well flowed clean oil along with a good showing of gas. Tester was open 60 minutes and gas was at the surface within 5 minutes. Hole was drilled to 3,404 ft. and casing run through the zones for completion through perforations.

Charles White and associates' new Cypress sand discovery well in the area 3 miles south of Keensburg, Wabash County, Illinois, has been put on the pump for completion, and at latest report was making 15 bbl. of oil per hour with oil standing 1,500 ft. in the hole. The well is on the operators' Garst lease in the SE SE SW 27-2s-13w. Cypress is open at 2,403-16 ft. (total depth).

C. Morburger and J. Anton have opened a new productive spot between the Birk City and Griffith areas in northwestern Daviess County where their 1 Cox, 6-P-28, pumped 42 bbl. of oil daily from McClosky lime at 1,817-20½ ft. Pay zone was treated with 1,000 gal. of acid.

Tuley & Carter have a prospective producer a mile from other production in the Owensville area, Gibson County, Indiana, where they are testing their 1 Witherspoon, SW SE NW 20-3s-11w, which has good saturation in Benoist sand at 2,328-38 ft. A drill-stem test of the zone yielded 15 ft. of clean oil and 43 ft. of mud-cut oil. No water was evident. Total depth is 2,591 ft.

ILLINOIS WILDCAT FAILURES

Bond County: H. Luttrell et al 1 Hallem, SE NE NW 30-4n-2w, dry, TD 1,177 ft.
John B. Buchman 1 Wise, NE NE NW 5-4n-2w, dry, TD 2,492 ft.
Clay County: Calvert Drilling, Inc., 1 Kremmerer, NE SE NW 34-4n-6e, dry, TD 3,044 ft.
Clinton County: Perry Fulk 1 Jasper, C S½ SW SW 10-3n-4w, dry, TD 3,380 ft.
Dale Hopkins 1 Cingatehaus, SW SW SW 27-2n-3w, dry, TD 2,602 ft.
Ash Drilling Co. 1 Meyers Hrs., NE SW SE 1-2n-4w, dry, TD 2,400 ft.
Douglas County: A. J. Leverton 1 Heaton, NE NE NE 34-16n-9e, dry, TD 754 ft.
Macoupin County: Roy Updike 1 Cooper, S½ NE NE SE 20-7n-7w, dry, TD 510 ft.
Montgomery County: Stewart Oil Co. 1 Morrell, NE NW NE 5-9n-3w, dry, TD 2,043 ft.

INDIANA WILDCAT FAILURES

La Grange County: J. W. Hunt 1 Sigrist, SE SE NW 19-37n-11e, dry, TD 2,357 ft.
Martin County: Ben Ruble 1 John and Marie, NW SE NE 12-3n-3w, dry, TD 400 ft.
Posey County: W. A. Schuller 1 Denbo, NW SW SW 3-7s-14w, dry, TD 2,958 ft.

WESTERN KENTUCKY WILDCAT FAILURES

Union County: Hiawatha Oil Co. 1 Cunningham Hrs., SW NE SE NW 22-O-17, dry, TD 2,892 ft.
Webster County: Illinois Mid-Continent Co. 1 Collins, NE SW SW NW 15-L-29, dry, TD 1,943 ft.

EASTERN KENTUCKY

ASHLAND.—In the Martha pool of northern Johnson County, Cumberland Petroleum Co. recently completed 16 Joseph Wheeler for 8 bbl. oil daily initial production from Weir (Mississippian) sand at total depth of 987 ft.

In Martin County sector of Big Sandy gas field, United Fuel Gas Co. has brought in 62 Federal Gas, Oil & Fuel Co. for an initial open flow of 5,006,000 cu. ft. of gas daily from the Big lime topped at 1,630 ft. Bottomed at 1,793 ft., the well showed a rock pressure of 443 psi. in 48 hours.

EQUIPMENT MEN

Angier Advanced to New Post by General Controls

F. H. ANGIER

General Controls Co., Glendale, Calif., has appointed Fred H. Angier district manager for the Philadelphia and Baltimore factory branch offices, according to an announcement by J. F. Ray, vice president in charge of sales.

Angier, who moves from the position of branch manager in Baltimore to his new post, will include in his territory the District of Columbia, Maryland, Virginia, West Virginia, the eastern half of Pennsylvania, lower New Jersey, and Delaware. He will direct sales and service activities on General's complete line of automatic pressure, temperature, level and flow controls.

Dowell Opens Branch Laboratory at Midland

A new district laboratory has been opened by Dowell Incorporated in Midland, Tex., to operate as a branch of the main chemical-research laboratory in Tulsa.

This new branch has been established to offer fast, improved service to operators in the Permian Basin area.

The Midland laboratory is fully equipped for complete testing of all types of oil-field samples such as cores, cuttings, brines, and paraffins, as well as industrial-scale samples.

James O. Means, who has been employed as a research chemist in Tulsa for several years, has been transferred to Midland to be in charge of the new laboratory.

McCollum, Ferris Open New Seismographic Firm

E. V. McCollum and Craig Ferris have formed GeoSeis, Inc., Tulsa, to render a more complete service to

E. V. McCOLLUM

CRAIG FERRIS

the oil industry. They are now associated with E. V. McCollum & Co., and the two firms will be closely associated. Their service in the field of seismographic prospecting will cover the United States and Canada.

In 1939 McCollum joined Mott-Smith Corp., Houston, as chief geophysicist. In 1943 he formed E. V. McCollum & Co., Tulsa, gravity and magnetic contractors.

Ferris was associated with Mott-Smith Corp. from 1938 until he joined McCollum in 1943.

Foxboro Adds Assembly Building to Main Plant

A new one-story building will add 50,000 sq. ft. to the working area in the headquarters of The Foxboro Co., Foxboro, Mass., maker of industrial instruments for measurement and control.

This building will be used principally for the final assembling and testing of recorders and controllers for temperature, pressure, liquid level, and flow.

Middle West Coating To Represent Tapecoat

Middle West Coating & Supply, Tulsa, has been appointed distributor by the Tapecoat Co. of Evanston, Ill., according to Al Bohne, president of the Tapecoat Co.

The addition of Tapecoat to its line makes Middle West able to offer a complete supply of products and equipment for corrosion mitigation from one source.

Eagle-Picher Elects Three New Directors

At the recent annual shareholders meeting of Eagle-Picher Co. held at the company's headquarters in Cincinnati, three new members were elected to the board of directors. They are: Stanley R. Miller, William H. Mitchell, and George A. Spiva.

Drilling Operations Still Hold Edge Over 1950; Completions Up 1.2 Per Cent

by Polly DeArmond

DRILLING operations in the current year continued to hold a slight edge over record-breaking 1950. The number of new wells completed during the first 3 months increased 115, or 1.2 per cent, over the same period of the previous year, and footage drilled was up some 2,387,000 ft., or 6.7 per cent. Percentagewise, increased activity in the Rocky Mountain region paced the gains: wells increased 54.2 per cent and footage was up 57.9 per cent. California rose 24.8 per cent in completions and 9.5 per cent in footage. The Mid-Continent states (Oklahoma, Kansas, and Nebraska) showed a 12.2 per cent gain in completions and a 17.4 per cent increase in footage drilled. The Texas-New Mexico area was up 1.4 per cent in wells and 6.2 per cent in footage. Declines were noted in three sections: the Appalachian fields were down 17.1 per cent in wells and 4.7 per cent in footage; the Southern states (Louisiana, Arkansas, Mississippi, Alabama, Georgia, and Florida) fell 15 per cent in completions and 7.2 per cent in footage; the North Central district (Ohio, Kentucky, Illinois, Indiana, and Michigan) were off 12.2 per cent in wells and 6.7 per cent in footage.

1951 vs. 1949.

Greater gains were noted in the comparison between January-March 1951 and 1949. Wells were up 745, or 8.5 per cent, and footage increased 5,799,000 ft., or 18 per cent. Increases by areas follow: Mid-Continent, up 56.8 per cent in wells and 57.8 per cent in footage; Rocky Mountain region, up 28.9 per cent in completions and 42.5 per cent in footage drilled; Texas et al., up 22.2 per cent in wells and 27.1 per cent in footage. While the Southern states noted a 2.4 per cent decrease in completions, footage was up 6.8 per cent for the comparative period. The Eastern states fell 48.6 per cent in wells and 37.1 per cent in footage. The West Coast was off 22.6 per cent in completions and 20.6 per cent in footage drilled. The North Central division declined 17.2 per cent in wells and 20.9 per cent in footage.

1951 vs. 1948

There were 1,138 more wells, or 13.5 per cent, drilled the first quarter of 1951 than in the corresponding period of 1948, and some 8,367,000 additional feet, or 28.3 per cent. Breakdowns by areas show that Texas-New Mexico jumped 48 per cent in completions and 51.1 per cent in footage, while the Mid-Continent was up 47.9 per cent in wells and 56.2 per cent in footage. The Rockies increased 21 per cent in completions and 22.4 per cent in footage, and the Southern states gained 3.5 per cent in wells and 23.9 per cent in footage. The East Coast slumped 55.7 per cent in completions and 45.6 per cent in footage drilled; the Pacific Coast was down 28.2 per cent in wells and 18.1 per cent in footage; the North Central section dropped 11.3 per cent in completions and 17.6 per cent in footage.

SUMMARY OF COMPLETIONS . . . MARCH 1951

	Total comp.	Oil	Gas	Dry	Under 2,500 ft.	2,500-5,000 ft.	5,000-7,500 ft.	7,500-10,000 ft.	10,000-12,500 ft.	Over 12,500 ft.	Total footage	Rigs and drilling
New York	44	22	0	22	44	0	0	0	0	0	64,000	52
Pennsylvania	113	52	15	46	100	13	0	0	0	0	197,039	208
West Virginia	45	6	33	6	19	26	0	0	0	0	128,596	164
Maryland	3	0	3	0	0	3	0	0	0	0	12,082	19
Ohio	87	27	20	40	47	38	2	0	0	0	191,264	112
Kentucky	69	34	9	26	60	9	0	0	0	0	105,437	81
Illinois	101	35	1	65	52	48	1	0	0	0	220,311	199
Indiana	54	15	2	37	43	11	0	0	0	0	99,418	198
Michigan	74	25	3	46	38	35	1	0	0	0	191,072	117
Kansas	320	160	31	129	35	280	5	0	0	0	1,058,147	409
Neb., Mo., Iowa	22	5	1	16	3	18	1	0	0	0	85,359	38
Oklahoma	424	252	16	156	124	205	66	7	22	0	1,604,012	831
Texas	1,502	912	61	529	366	536	390	162	43	5	6,921,235	1,442
North	240	130	2	108	122	87	30	1	0	0	711,080	197
West Central	199	88	7	104	57	116	26	0	0	0	664,214	181
West	463	357	1	105	80	117	194	48	19	5	2,519,418	479
Panhandle	53	24	25	4	8	45	0	0	0	0	159,042	91
East	94	62	0	32	16	43	21	13	1	0	441,407	115
Gulf Coast	218	119	18	81	22	52	59	66	19	0	1,373,437	210
Southwest	235	132	8	95	61	76	60	34	4	0	1,052,637	169
Louisiana	174	96	15	63	27	37	24	29	49	8	1,211,908	238
Northern	81	47	11	23	26	28	16	9	2	0	323,183	104
Southern	93	49	4	40	1	9	8	20	47	8	888,725	134
Arkansas	21	11	1	9	4	13	3	1	0	0	75,545	27
Mississippi	22	5	0	17	1	2	11	4	4	0	156,783	32
Ala., Ga., Fla.	3	3	0	0	0	1	2	0	0	0	14,302	6
Montana	14	10	0	4	10	4	0	0	0	0	31,379	§40
Wyoming	70	47	3	20	3	39	18	6	3	1	371,923	¶161
Colorado	17	9	1	7	0	8	7	2	0	0	86,462	58
Utah	3	1	0	2	2	0	1	0	0	0	8,601	21
New Mexico	67	33	17	17	16	28	13	6	4	0	296,037	**98
Idaho	1	0	0	1	0	0	0	0	0	1	12,844	1
California	183	135	5	43	56	78	27	13	7	2	733,629	227
Total March 1951	3,433	†1,895	237	*1,301	1,050	1,432	572	220	132	17	13,871,385	‡4,779
Total February 1951	2,729	1,518	209	1,002	838	1,180	465	150	81	15	10,824,010	4,731
Total March 1950	3,444	2,017	229	1,198	1,205	1,346	610	202	71	10	12,994,200	4,560
Cumulative 1951	9,534	5,330	667	3,537	2,937	4,070	1,611	588	287	41	37,873,396	....
Cumulative 1950	9,419	5,489	643	3,287	3,343	3,740	1,565	518	221	32	35,486,868	....

*Incl. 84 service wells: N. Y. 22, Pa. 41, Ohio 6, Ill. 3, Ind. 1, Kans. 3, Okla 5, So. La. 1, Calif. 2. †Incl. 49 distillate wells: Okla. 17, W. Tex. 7, E. Tex. 5, Tex. Gulf 7, S.W. Tex. 6, So. La. 6, Miss. 1. ‡Incl. wells rigged up and/or drilling at month end. §Incl. 3 Nev. rigs. ¶Incl. 5 Dak. rigs. **Incl. 3 Ariz. rigs.

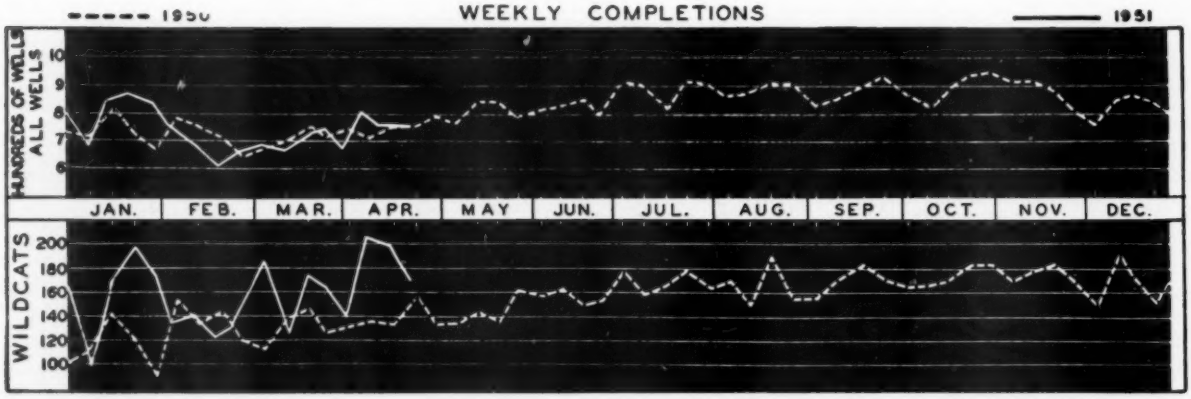
CURRENT STATISTICS

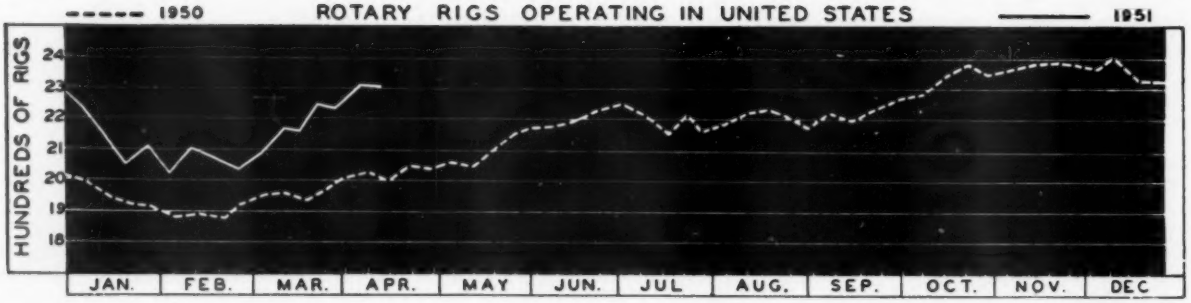
EXPLORATION

WEEKLY WELL COMPLETIONS . . . . . WEEK ENDED APRIL 21, 1951

	Total of all wells					Apr. 21		Wildcat completions and discoveries										
													Cumulative total, 1951					
	Comp.	Oil	Gas	Dry	Footage	1951	1950	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	7	4	0	*3	10,192	119	171	0	0	0	0	0	0	0	0	0	0
Pennsylvania	11	5	1	†5	18,727	246	318	0	0	0	0	0	0	0	0	1	1
West Virginia	9	1	6	2	28,829	180	190	0	0	1	0	1	0	0	5	2	7
Ohio	15	9	2	‡4	18,551	242	279	0	0	0	0	0	1	0	3	9	13
Indiana	18	6	0	12	35,257	287	321	0	0	0	3	3	8	0	1	63	72
Kentucky	17	10	2	5	29,598	236	246	0	0	0	2	2	3	0	0	39	42
Illinois	30	11	0	19	70,014	471	616	0	0	0	9	9	11	0	0	80	91
Michigan	9	3	0	6	20,758	206	213	1	0	0	4	5	4	0	3	85	92
Kansas	79	42	1	36	263,786	1,233	1,045	2	0	0	18	20	57	0	4	225	286
Nebraska	4	0	0	4	15,610	90	21	0	0	0	4	4	2	0	1	42	45
Oklahoma	127	68	4	†55	425,989	1,654	1,521	3	0	0	22	25	61	1	8	218	288
Texas	304	185	7	112	1,282,947	4,853	4,778	14	1	1	60	76	203	20	33	895	1,151
North Central (Dist. 7-B & 8)	104	43	1	†60	335,428	1,463	1,491	10	0	0	37	47	104	0	5	373	482
West (Dist. 7-C & 8)	94	69	0	25	462,137	1,484	1,396	2	1	0	13	16	37	6	1	182	226
Panhandle (Dist. 10)	15	10	3	2	44,699	213	318	0	0	0	1	1	0	0	0	10	10
Eastern (Dist. 5, 6, & 6-P)	17	12	0	5	74,752	349	322	0	0	0	0	0	1	1	0	68	70
Gulf Coast (Dist. 2 & 3)	33	27	1	5	190,882	673	646	1	0	1	2	4	33	9	22	121	185
Southwest (Dist. 1 & 4)	41	24	2	15	175,049	671	605	1	0	0	7	8	28	4	5	141	178
Louisiana	34	20	2	12	205,264	603	700	0	0	0	3	3	16	0	4	81	101
Northern	19	13	2	4	82,673	288	365	0	0	0	1	1	4	0	3	42	49
Southern	15	7	0	8	122,591	315	335	0	0	0	2	2	12	0	1	39	52
Arkansas	6	4	0	2	16,367	116	105	0	0	0	1	1	3	0	1	20	24
Mississippi	5	1	0	4	39,868	72	100	0	0	0	3	3	4	2	0	30	36
Southeastern States	0	0	0	0	0	16	19	0	0	0	0	0	0	0	0	3	3
Montana	6	6	0	0	11,882	62	47	0	0	0	0	0	0	0	0	18	18
Wyoming	13	7	1	5	52,906	206	160	0	0	0	1	1	4	0	0	32	36
Colorado-Utah	11	5	1	5	60,918	79	20	0	0	1	5	6	2	0	2	38	42
New Mexico	13	6	2	5	73,095	200	206	1	0	0	2	3	5	0	5	23	33
California	35	26	0	9	145,070	600	506	0	0	0	7	7	14	0	1	125	140
Miscellaneous (Mo.)	1	0	0	1	937	14	5	0	0	0	0	0	0	0	6	7	13
Total United States	754	419	29	306	2,826,535	11,785	11,587	21	1	3	144	169	398	23	77	2,036	2,534
Total previous week	761	385	46	330	2,901,337	....	....	31	0	4	164	199	377	22	74	1,892	2,365
Total April 21, 1950	749	430	33	286	2,875,333	....	....	23	0	1	133	157	295	20	65	1,724	2,104

Service wells included: *3, †5, ‡1.





DAILY AVERAGE PRODUCTION FOR WEEK

	Apr. 21 crude oil	B. of M Apr. demand	Apr. 14 crude oil
Alabama	2,800	2,400	2,750
Arkansas	78,000	86,000	77,950
California	965,500	970,000	965,300
Colorado	77,900	79,000	77,800
Eastern	59,000	66,000	59,600
Florida	1,650	1,600	1,550
Illinois	159,600	166,000	158,700
Indiana	27,600	31,000	25,600
Kansas	319,400	308,000	305,100
Kentucky	27,600	31,000	27,300
Louisiana	609,475	632,000	609,025
North Louisiana	114,550	.....	114,100
South Louisiana	494,925	.....	494,925
Michigan	38,400	45,000	38,100
Mississippi	100,550	112,000	98,350
Montana	24,100	24,000	24,200
Nebraska	9,350	10,000	9,900
New Mexico	143,850	142,000	143,850
Oklahoma	503,700	506,000	492,950
Texas	2,725,375	2,500,000	2,725,375
Dist. 1 (Southwest)	33,525	.....	33,525
Dist. 4 (Southwest)	254,650	.....	254,650
Dist. 2 (Gulf Coast)	162,325	.....	162,325
Dist. 3 (Gulf Coast)	481,825	.....	481,825
Dist. 5 (Eastern)	51,475	.....	51,475
Dist. 6 (Eastern)	111,575	.....	111,575
East Texas field	279,000	.....	279,000
Dist. 7-C (West)	91,725	.....	91,725
Dist. 8 (West)	935,900	.....	935,900
Dist. 7-B (W. Central)	83,425	.....	83,425
Dist. 9 (N. Central)	150,250	.....	150,250
Dist. 10 (Panhandle)	89,700	.....	89,700
Utah	3,700	5,000	3,700
Wyoming	200,200	183,000	198,100
Total United States	*6,077,750	5,900,000	6,045,200
Change from previous week, up	32,550		
Canada	87,980	.....	93,285

Total U. S. production January 1-April 21 ..... †653,670,045 bbl.
Same period last year (crude plus cond.) ..... 589,702,695 bbl.

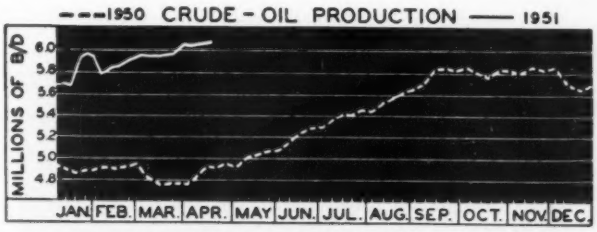
*Not including 109,855 bbl. condensate. †Including 11,854,640 bbl. condensate.

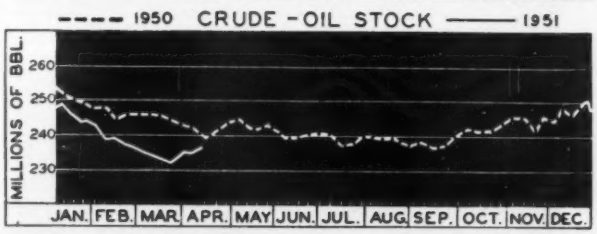
CRUDE-OIL STOCKS BY STATES OR ORIGIN*

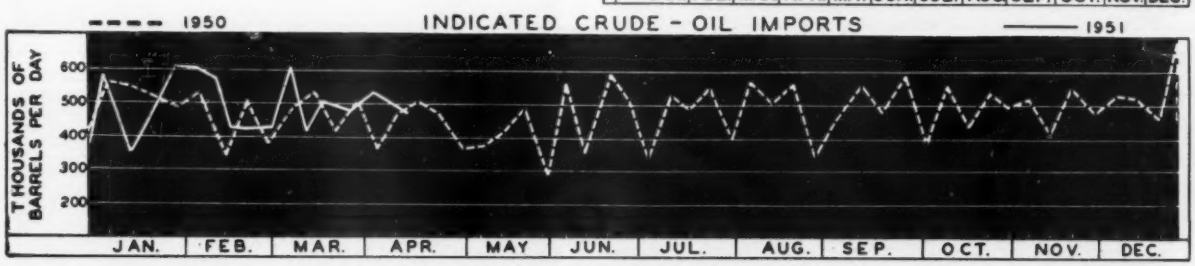
(Thousands of barrels)

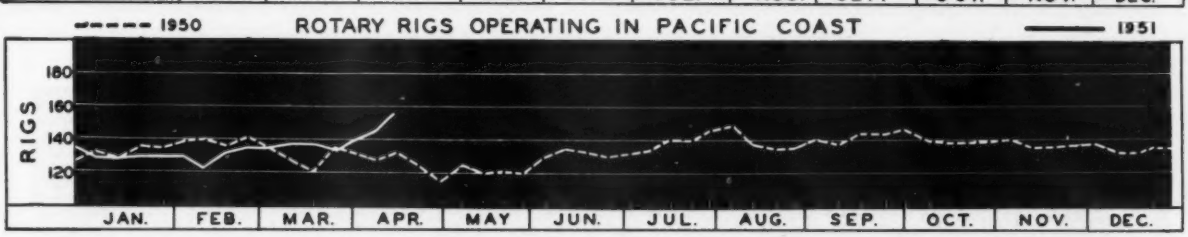
	Apr. 14, 1951	Apr. 7, 1951	Apr. 15, 1950
Pennsylvania Grade	2,078	2,059	2,742
Other Appalachian	1,486	1,408	1,512
Illinois, Indiana, Michigan	9,359	9,275	9,860
Arkansas	2,922	2,817	3,034
Louisiana	14,526	14,382	14,816
North	3,203	3,034	3,362
Gulf	11,323	11,348	11,454
Mississippi	3,087	2,996	2,472
New Mexico	7,114	7,063	6,549
Oklahoma and Kansas	36,748	37,473	35,283
Texas	109,603	108,128	106,729
East Texas	14,585	14,366	14,223
West Texas	45,223	44,447	39,251
Texas Gulf	23,633	23,697	27,467
Other Texas	26,162	25,618	25,788
Rocky Mountain	13,174	13,087	13,442
California	30,477	30,437	38,174
Foreign	6,532	6,471	6,711
Total	237,106	235,596	241,324

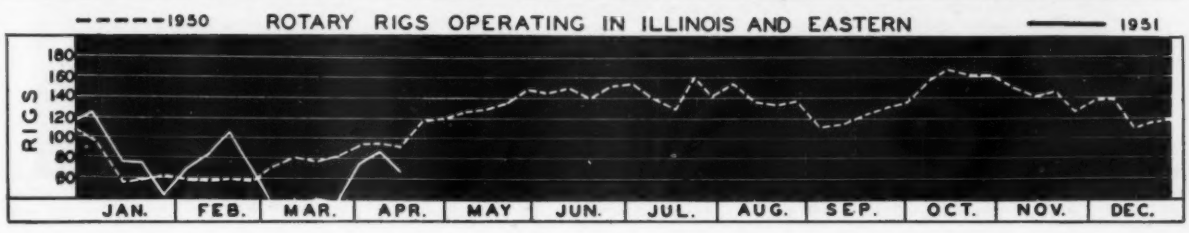
*Bureau of Mines.









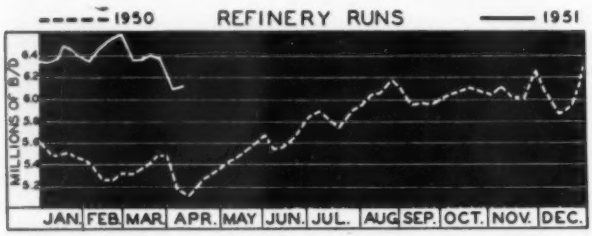


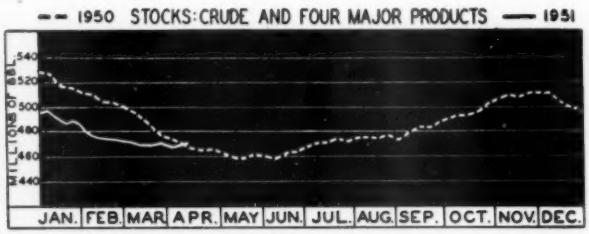
A.P.I. REFINERY REPORT, APRIL 14

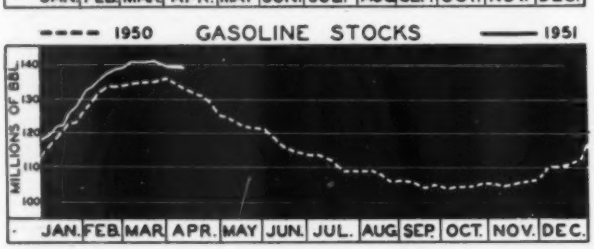
(Thousands of barrels)

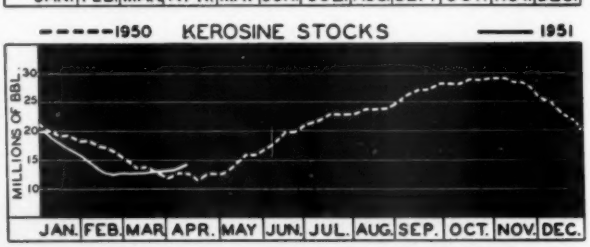
District—	Daily avg. crude runs	Daily average production: Gasoline*	Kerosine	Distillate	Residual	Stocks at refineries, bulk terminals, in transit and in pipe lines: Gasoline†	Kerosine	Distillate	Residual	Bureau of Mines, April 1950: Daily avg. crude runs	Daily average production: Gasoline*	Kerosine	Distillate	Residual
East Coast	934	359.6	41.4	211.0	192.1	26,996	5,799	12,694	8,209	871	360.0	34.4	172.9	201.4
Appalachian:														
District 1	105	42.8	6.0	12.4	13.6	2,869	272	469	275	88	37.0	7.4	11.9	10.7
District 2	79	37.9	5.4	9.1	14.9	1,446	91	154	112	72	32.6	4.4	9.0	15.9
Ind., Ill., Ky.	1,071	537.0	74.3	171.8	171.3	32,034	2,553	7,099	2,818	935	470.1	63.0	155.0	151.9
Okla., Kans., Mo.	515	269.6	21.1	108.6	65.0	16,420	710	4,942	1,000	430	241.0	19.0	88.8	58.1
Inland Texas	231	141.7	12.4	38.7	46.9	3,917	302	552	709	193	132.6	11.5	23.5	39.7
Texas Gulf Coast	1,512	662.7	134.9	318.0	278.4	22,777	1,999	5,437	4,504	1,081	531.9	83.8	226.3	195.0
La. Gulf Coast	483	219.8	66.0	126.1	58.6	7,081	1,531	2,507	1,418	442	231.7	51.6	98.3	44.7
N. La. and Ark.	86	32.6	9.0	18.0	8.7	2,694	229	657	69	70	25.3	7.0	15.0	12.4
Rocky Mountain:														
New Mexico	15	8.3	.....	2.9	3.0	90	25	60	29	14	7.7	0.4	2.3	3.5
Other Rocky Mtn.	178	83.3	1.6	34.6	43.1	5,780	237	1,200	713	157	73.4	2.4	31.8	33.4
California	918	372.0	12.3	161.9	366.4	17,327	589	7,432	16,970	840	364.6	10.1	141.9	274.1
April 14, 1951	6,127	2,767.3	384.4	1,213.1	1,262.0	139,431	14,337	43,203	36,826	5,193	2,507.9	295.0	976.7	1,040.8
April 7, 1951	6,092	2,758.0	328.7	1,284.0	1,268.1	139,728	13,533	42,354	36,532	.....	.....	.....	.....	.....
April 15, 1950	5,116	2,403.9	292.0	966.7	1,077.3	133,458	12,686	37,499	39,881	.....	.....	.....	.....	.....

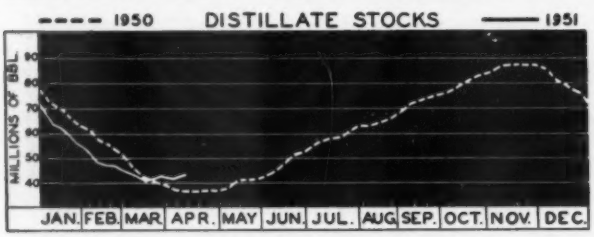
*At refineries including natural blended. †Finished and unfinished.

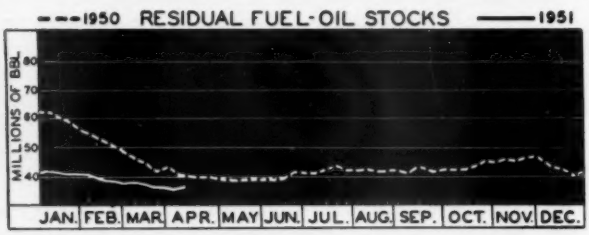




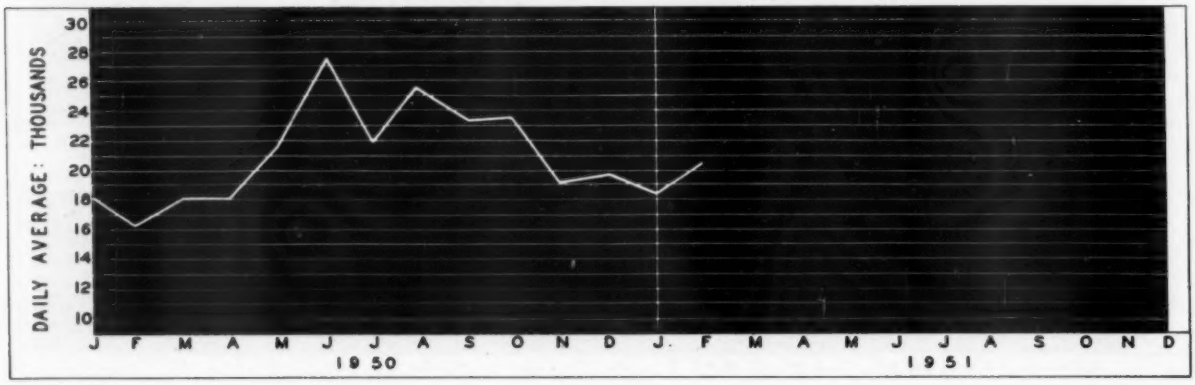








MOTOR-VEHICLE SALES (DOMESTIC MARKET)



CRUDE PRICES
GRAVITY SCHEDULE

	Signal Hill, Calif.‡	Oklahoma, Kansas	Gulf Coast Tex.*	West Tex.†
18-18.9	$1.93	....	....	....
19-19.9	1.98	....	....	....
20-20.9	2.03	$2.25	....	$2.12
21-21.9	2.07	2.27	....	2.14
22-22.9	2.12	2.29	....	2.16
23-23.9	2.18	2.31	....	2.18
24-24.9	2.24	2.33	$2.56	2.20
25-25.9	2.30	2.35	2.58	2.22
26-26.9	2.36	2.37	2.60	2.24
27-27.9	2.41	2.39	2.62	2.26
28-28.9	2.46	2.41	2.64	2.28
29-29.9	2.52	2.43	2.66	2.30
30-30.9	2.57	2.45	2.68	2.32
31-31.9	2.62	2.47	2.70	2.34
32-32.9	2.68	2.49	2.72	2.36
33-33.9	....	2.51	2.74	2.38
34-34.9	....	2.53	2.76	2.40
35-35.9	....	2.55	2.78	2.42
36-36.9	....	2.57	2.80	2.44
37-37.9	....	2.59	2.82	2.46
38-38.9	....	2.61	2.84	2.48
39-39.9	....	2.63	2.86	2.50
40 and above	....	2.65	2.88	2.52

*For crude from Daboval, El Campo, and Sand Point.

†Includes Lea County, New Mexico. Last general price change represented a 50-cent increase becoming effective December 6 1947.

‡Standard Oil Co. of California.

FLAT CRUDE PRICES

Representative posted schedules per barrel.

East Texas†	$2.65
Kettleman Hills, California*	2.80
Beauregard Parish	2.60
Illinois Basin	2.77
Pecos County, Texas (Yates)	2.35
Bradford, Pennsylvania	4.25
Eastern Ill. and Western Ind.†	2.77
Tomball, Texas Gulf Coast	2.83

*37°-37.9°. †35° and above.

IF extreme weather conditions next winter cause spot shortages in certain high-demand areas, the lack of supply can be charged to insufficient primary storage and not to any lack of producing and refining capacity.

Officials of Petroleum Administration for Defense have estimated that storage capacity was increased 58,000,000 bbl. last year and have forecast the 1951 increase at 50,000,000 bbl. Past surveys have shown that only about half of total tank space will be filled with available material, the other half being required for working storage and working space to cover variations in receipts and deliveries at terminals. This cuts the actual 2-year increase to about 50,000,000 bbl.

However, the big deficiency in the storage-construction program is the failure on the part of some suppliers to add to over-all storage capacity. The major part of the increase has been by a relatively small number of the larger operators. Refiners with insufficient storage capacity will have to cut back on runs during the summer months unless there is a normal flow of kerosine and distillate fuels to secondary suppliers.

If these refiners operate at capacity in the early part of the gasoline season, they may fill all space available for heating oil by the middle of summer. The situation could develop in which these suppliers would have to dump some kerosine and distillate on the market in order to continue operations at a rate required to meet their gasoline demands. Even the slightest indication of a soft fuels market tends to slow down purchases by resellers and secondary suppliers, particularly inventory-building purchases. In order to meet next winter's demands, both primary and secondary storage should be filled at the beginning of the season. In the past, price cuts have not promoted secondary fillups.

REPRESENTATIVE QUOTATIONS

Representative spot-market quotations of leading suppliers as of April 23, 1951. Figures are f.o.b. plant for tank-car shipments in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline, 80-82 octane	10⅛-10½	12-12.75	10¾-11
Premium gasoline, 86-88 octane	11⅜-11½	13.5-13.75	11¾-12
42-44 w.w. kerosine	9¼-9⅜	10	8½-9
No. 2 straw fuel oil	8¼-8⅝	9-9.25	7½-8
No 6 residual	$1.75-1.90	$2.25-2.30	$1.75-1.90

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	5½	5	5¼
Grade 18-55	6.6	6.1	6.35

LUBRICATING OILS

South Texas

200 vis., No. 2-3 neutral	13-13.5
750 vis., No. 3-4 neutral	16
2,000 No. 5-6 neutral	18-19

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	29-30
200 vis., No. 3 neutral, 0-10 pp.	17.5-18.5

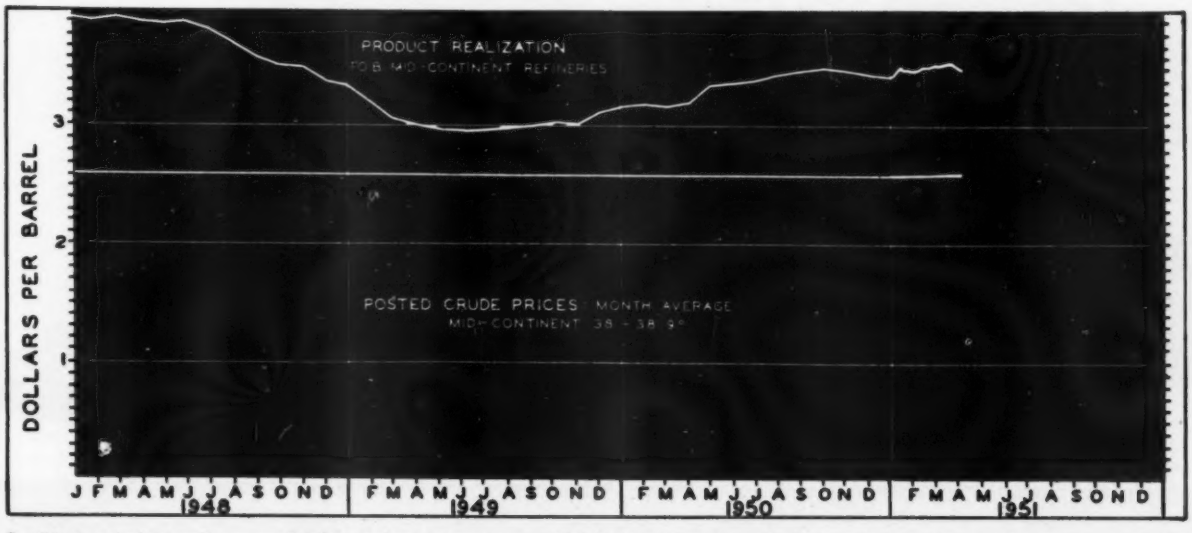
Western Pennsylvania

145-155 vis., 10 p.t. bright stock	32.5
180 vis., 0 p.t. neutral	31.5

WAX

Mid-Continent

132-134 A.M.P.	6.0


PRODUCT REALIZATION
TO B MID-CONTINENT REFINERIES
POSTED CRUDE PRICES MONTH AVERAGE
MID-CONTINENT 38 - 38.9°
DOLLARS PER BARREL
3
2
1
J F M A M J J A S O N D
1948
F M A M J J A S O N D
1949
F M A M J J A S O N D
1950
F M A M J J A S O N D
1951

In this trend chart refinery realization is based on average Mid-Continent grade crude oil (not 38° gravity only) and average prices for refinery products as published in The Oil and Gas Journal basis Oklahoma (Group 3). Refinery yields confined to gasoline, kerosine, distillate, and fuel oil. Realization averaged $3.50 for week ended April 14, $3.55 for previous week, and $3.24 for April 1950.

HERE ARE THE FACTS AS REPORTED BY A MAJOR OPERATOR!

PARKERSBURG *Air Balanced* PUMPERS

. . . Cost less to own

. . . Save thousands of dollars on rod job and maintenance costs*!

NO ROD JOBS

With conventional pumping units, sucker rod jobs averaged between 15 and 25 per unit for the one year test period and none for the Parkersburg Air Balanced Pumper.

NO MAINTENANCE COSTS

During the test period neither the surface nor sub-surface equipment required any expenditure for maintenance.

SAVES THOUSANDS OF DOLLARS PER YEAR

Maintenance costs on some other types of pumps ran from $1875 to as much as $4375 during the one year test.

YOU CAN'T IGNORE ECONOMY

When actual tests prove that you can save almost $5000 per year on maintenance costs alone on one deep well, you're getting the kind of economy that means money in the bank.

Your Parkersburg Representative will give you complete details of the many advantages of Parkersburg Air Balanced Pumpers for your deep wells.

THE PARKERSBURG RIG & REEL CO.
PARKERSBURG, WEST VIRGINIA

*From actual records of a major oil company.

PARKERSBURG
PUMPERS *Air Balanced • Chain Driven • Gear Driven*

Manufactured in Coffeyville, Kansas

EQUIPMENT MEN . . . in the News

Maintenance Engineering Names Halderman Director

The election of E. B. Halderman as a director of Maintenance Engineering Corp. at the annual meeting of stockholders has been announced by C. E. Naylor, president.

Halderman went to work for Lukens Steel Co., Coatesville, Pa., in 1932. After 4 years with Lukens he resigned to join Maintenance Engineering in Houston where he specializes in handling Lukens steel maintenance products.

Changes in Sales Staff Made by Oil Center Tool

Two changes in the Oil Center Tool Co. sales organization have been announced by Rex Galloup, sales manager.

A. M. TAYLOR

C. B. WRIGHT

A. M. Taylor, formerly with Bethlehem Supply Co., has been added to the sales organization and will make his headquarters in Oklahoma City.

C. B. Wright, formerly in the O-C-T Oklahoma City sales office, has moved to Dallas. He will serve the North Texas territory from his Dallas headquarters.

Halliburton Plant Holds Anniversary Celebration

On April 1, Halliburton Portland Cement Co., Corpus Christi, celebrated its first anniversary of cement production. Approximately 1.2 million barrels of Shell Brand Portland cement were manufactured during the year.

The immense Halliburton plant sprawls over an area of about 50 acres, and is operating on a 24-hour-a-day schedule employing approximately 150 employes.

The plant was constructed by Erle P. Halliburton. Operating personnel of the plant include: Erle P. Halliburton, Jr., vice president; Ellroy King, vice president, secretary, and treasurer; R. A. Beaver, assistant secretary and assistant treasurer; A. J. Anderson, works manager; H. R. Gingerich, chief chemist; Keith Sandefer, plant engineer; and Marshall Clements, sales manager.

Niemeier Named to New Post

Petroleum Specialty Co., manufacturers of Crall spiral paraffin scrapers, has appointed Fred Niemeier sales manager of the Rocky Mountain and Western Canada divisions of the company.

Niemeier has been sales representative of the company since 1948, and served in Oklahoma, Kansas, and Illinois. He was formerly affiliated with Jarecki Supply Co. offices in Kansas and Texas.

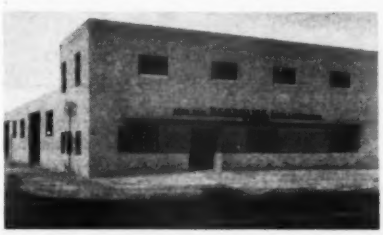
Parkersburg Reelects A. S. Knowles President, Chairman

A. Sidney Knowles was reelected president of The Parkersburg Rig & Reel Co., and named chairman of the board of directors at the annual stockholders' meeting held in Parkersburg, W. Va., on April 6.

As chairman of the board of directors, Knowles succeeds John M. Crawford, founder of the company, who held the position at the time of his death in July of last year.

Other officers who were reelected are W. V. Rathbone, vice president and general manager; B. M. Farson, vice president and treasurer; A. G. Evans-Lombe, vice president, sales; R. G. De La Mater, vice president, engineering; D. C. Myers, vice president, and Paul O. Summers, secretary.

Grancell Erects New Plant



I. H. Grancell, Los Angeles, manufacturer of Bestolife lead seal pipe joint compounds, has just completed construction of this new plant over the old plant. The new plant occupies 9,400 sq. ft. of floor space.

Romberg to Head Southern Division of Geophysical

Frederick E. Romberg has been appointed division manager of the southern division of Geophysical Service, Inc. He will be in charge of all operations in Texas, Louisiana, Arkansas, and Mississippi, with headquarters in Houston.

Romberg was employed by Geophysical Service as a computer in 1933 and became a party chief in 1934. In 1939 and 1940 he worked in the Los Angeles office, developing new computational methods and equations. In 1941 he took leave of absence from G.S.I. to work as gravitymeter technician for LaCoste & Romberg in Austin. He developed various aspects of gravity meters and wrote papers on the application of gravity data to geophysics.

Lewis Joins Engineering Firm of Cable & Stine

Roger Lewis recently joined the petroleum - engineering firm of Cable & Stine, Wichita Falls, Tex. He was previously an employe of the Bureau of Mines and had participated in a study of the southwest part of the Kamay, Tex., field, a study which reviewed the effectiveness of the pressure-maintenance project which has operated in that field for a number of years.

Lewis is a graduate petroleum engineer from University of Texas.

McKey Appointed to R.C.A. Sales Force in Dallas

Dixie B. McKey, prominent radio-engineering consultant, has been appointed a field sales representative for R.C.A. microwave and mobile communications products with headquarters in Dallas, it was announced by C. M. Lewis, manager of broadcast and communications sales, R.C.A. engineering products department.

McKey will supervise sales and installation of R.C.A. microwave equipment throughout the southern United States. He will also act as field

sales representative for R.C.A. mobile equipment in the eastern Texas territory.

Prior to his affiliation with R.C.A. McKey was owner and operator of the consulting radio engineering firm of Dixie B. McKey & Associates, Washington, D. C.

Halliburton Names Gillham, King to New Positions

LOCKIE GILLHAM

Lockie Gillham has been transferred by Halliburton Oil Well Cementing Co. from Hugoton, Kans., to Newcastle, Wyo. Gillham has been made district superintendent in charge of Halliburton operations in Newcastle and Lance Creek, Wyo., with headquarters in Newcastle.

Halliburton also announces the transfer of Frank King from Newcastle to Lovell, Wyo., where he will be in charge of operations at Lovell, Worland, and Powell, Wyo., and Cut Bank and Roundup, Mont. His headquarters will be in Lovell, Wyo.

Peerless Holds Annual District Managers Meeting

Personnel attending annual district managers' meeting of Peerless Pump Division, Food Machinery & Chemical Corp., held last month in Los Angeles, are: J. F. Van Dam, Los Angeles; E. H. Hansen, Fresno; R. F. Foster, Los Angeles; F. D. Widener, Los Angeles; R. H. Hull, Indianapolis; E. H. Lanthorn, Indianapolis; B. A. Tucker, Los Angeles; C. C. Cook, Atlanta; W. E. Griffin, Dallas; G. D. Sickert, Indianapolis; F. W. McCann, New York; G. F. Twist, FMC vice president and Peerless division manager; C. L. Nickel, Indianapolis; J. C. Bonsall, Los Angeles; J. H. Raths, Indianapolis; V. L. Ray, Los Angeles; C. H. Sorter, Fresno; A. F. Barron, Chicago; E. W. Lundy, Los Angeles; S. M. Riordan, Los Angeles; J. B. Downie, Los Angeles.

Peerless Pump Division of Food Machinery & Chemical Corp.'s annual meeting, which was held in Los Angeles in March, was opened by G. F. Twist, vice president of F.M.C. and general manager of the Peerless Pump Division. Twist gave a brief resume of the accomplishments of 1950 and outlined the strategy for the current sales year.

In addition to district managers of Peerless, were representatives from the Peerless Pump works at Indianapolis as well as from the Los Angeles works of the company, with administrative personnel.

Koppers to Build Pipe Coatings, Roofing Plant

Koppers Co., Inc., has taken an option on 158 acres of land at Fontana, Calif., and contemplates construction of a plant there for the making of enamel pipe coatings and roofing materials, it has been announced by Fred C. Foy, vice president and general manager of Koppers tar products division.

The proposed site is adjacent to the Kaiser Steel Co. plant, and Koppers plans to use pitch made from tar obtained from the Kaiser Steel Co. coke ovens, processing it into high-grade enamels for pipe coatings and various types of roofing materials.

Blom Named to Executive Position by Byron Jackson

CARL BLOM

Carl Blom has been elected a vice president of Byron Jackson Co., according to an announcement made by E. S. Dulin, president.

Blom joined Byron Jackson in 1924. As chief engineer of the pump division, he has directed many important projects. He cooperated with California Institute of Technology in the original design and manufacture of six BJ pumps for the $220,000,000 Colorado River aqueduct. As a result of this project, details of design of the "World's Largest" pumps for Grand Coulee dam, near Spokane, Wash., were applied.

Well Equipment Representatives Attend Sales Session

In preparation for an intensive national sales drive, Well Equipment Manufacturing Corp., sales organization from Texas, New Mexico, Oklahoma, Kansas, Louisiana, Mississippi, and Arkansas traveled by chartered bus to Lake Charles, La., where they were guests of Home Gas & Fuel Co. Those attending the meeting were, back row: Howard Smith; B. H. Bohmfalk, J. H. Winton of Winton Automatic Gas Co.; V. E. LaGrange; Howard Corney, Home Gas & Fuel Co.; C. J. Meadows, Hartford Accident & Indemnity Co.; John W. Gates; F. A. Jordan; C. J. Holcomb; T. R. Shields; A. H. Watts, Well Equipment Manufacturing Corp., and Clyde Bier, Home Gas & Fuel Co. Front row: Earl Hardee, Home Gas & Fuel Co.; H. J. Hagn, vice president and general manager, Well Equipment; Jack LaDue, Gas Equipment Co., Inc.; L. L. Durkin; Don Palmer; Bill Brien; J. C. McCelvey; C. E. Gisler; Fred Tieman; and Tracy T. Word, Jr., sales manager, Well Equipment.

Blaw-Knox Constructs Heating Plant in Texas

Chemical-plants division of Blaw-Knox Co. has announced completion of construction of an amine-treating plant near Dumas, Tex., for Canadian River Gas Co. Built in the record time of 5 weeks, this new plant removes sulfur from sour natural gas to improve the fuel's value and to decrease corrosion in transmission lines.

(Additional Equipment News on Page 234)

Your MARKET PLACE FOR THE OIL AND GAS INDUSTRY... CLASSIFIED ADVERTISING

UNDISPLAYED CLASSIFIED 12c a word one issue. 10% Discount three or more issues. $3.00 minimum charge. Blind Box in our care counts nine words. Payable in Advance.

DISPLAY CLASSIFIED
$12.00 a column inch one issue . . .
10% Discount three or more issues.

EQUIPMENT FOR SALE

USED ROTARY AND CABLE TOOL DRILLING TOOLS, WIRE LINES, E. A. KELLY, BOX 661, OKLAHOMA CITY. PHONE 5-6407.

FOR SALE: 17½" Oilbath Gumbo Buster Rotary Table. 2—6" Gumbo Buster Swivels. Melton Supply Company, Seminole, Oklahoma.

LIKE NEW—97' Lee C. Moore Mast, 6' Substructure, Steel flooring, 4000' Good drilling pipe. Fred H. Kiel, Phone 2-7333—Wichita Falls, Texas.

FOR SALE: About 2500 feet of 8⅝-in. Lapweld, Range 1, oil well casing. Good, clean and ready to run. C. H. Reser, Hamilton, Kansas. Phone 2791.

FOR SALE: 1 RL Cardwell, double drum, with four-legged mast. In good working condition, now working. Box 871, Seminole, Oklahoma.

FOREIGN SEAMLESS CASING
A. P. I. Specifications. Subject to letter of credit. Box D-981, The Oil and Gas Journal, Tulsa, Oklahoma.

IMMEDIATE SHIPMENT
3100' 13⅜" OD 54.5# J-55 8-RT, Range 2
2000' 16" OD 65# H-40 8-RT, Range 1 & 2
No. 1 Used Seamless Casing
16 mi. 6⅝" OD 18.97# No. 1 Used Lapweld P.E. Line Pipe S.R.L. Beveled.
FRANK MORRIS & COMPANY
SPECIAL REPRESENTATIVES—TUBULAR PRODUCTS
424 So. Cheyenne Tulsa, Oklahoma

Gaso Duplex 4½" x 6" Power Pumps with Chrysler C-36 Engines, skid mounted, immediate delivery. Also Byron Jackson, Carter Centrifugal Units. Westinghouse 20-25-50 KW Generating Units
H. H. COFFIELD
Attn.: W. H. ORR
Phones: 132—Rockdale, Texas
AT-3427—Houston, Texas

26,000 feet 4" OD NEWSTEEL PIPE

12 gauge wall
40 ft. lengths
Electric weld
Double dipped in tar
650 lb. pressure tested
Immediate delivery
Subject to prior sale
Write—Wire—Phone

Sonken-Galamba Corporation
2nd and Riverview (X-709)
Kansas City 18, Kansas
THatcher 9243

EQUIPMENT FOR SALE

CASING PULLING CONTRACTORS with Hydraulic Equipment: Experienced operators—Pull any size pipe, anywhere. Also will buy wells for salvage. GENERAL CASING PULLING CO., P.O. Box 4387, Oklahoma City. Phone 6-1335.

FOR SALE or Lease with Purchase Option: Complete drilling rig, capacity 5000 feet, with practically new Model RL Cardwell drawworks. 7¼ x 12 Gardner-Denver pump. 96 foot cantilever type derrick. Box D-975, The Oil and Gas Journal, Tulsa, Oklahoma.

EQUIPMENT FOR SALE

FOR SALE: One Houston Portable Rotary Drilling Rig complete. Excellent condition, ready to drill wells up to 6000 Ft. Two strings Drill Pipe. Contact H. H. Blair, 600 Bitting Building, Wichita 2, Kansas. Telephone #7-3241.

FOR SALE: Used 4000 volt 150 K.W. electric generating plant: 2, 110 h.p. Reid oil engines, 2, 75 k.w. generators with exciters, 4 panel switchboard complete with transformers, voltage regulators, complete with all connections and accessories. Bargain. Box 370, Lyons, Kansas.

FOR SALE
AVAILABLE IN ONE LOT FOR IMMEDIATE SHIPMENT

3—DIESEL TORQUE CONVERTERS

Engines: Twin GM Model 6-71 (Completely Remanufactured and Guaranteed)
Torque Converters: New Twin Disc Model F

1—DIESEL POWER UNIT

Engine: Twin GM Model 6-71 (Completely Remanufactured and Guaranteed)
Reduction Gear: New GM 1-77:1 Heavy-Duty

DIESEL DIVISION—NATIONAL METAL & STEEL CORP.
Dept. OJ, Terminal Island (Los Angeles Harbor), Calif.
Telephone: Los Angeles—Nevada 6-2517

CASING, TUBING AND LINE PIPE

BUY NOW FOR YOUR SPRING REQUIREMENTS
LARGE QUANTITIES — IMMEDIATE DELIVERY

500,000' ½" Standard Black Welded Plain End, 21' Lengths
100,000' 2" Standard Black Welded Plain End, 21' Lengths
100,000' 2¼" OD x .140" Wall 3.2# Recond. Seamless Tubing (Sub. 2" Std.)
25,000' 2⅞" OD x .150" Wall 4.5# Seamless Pipe (Sub. 2½" Std.)
75,000' 5⅝" OD x .258" Wall 14.87# Used Lapweld, 21' Lengths
100,000' 7" OD 17# & 20# Used Lapweld Casing (Sub. 6⅝" or 8⅝" O.D. Line Pipe)

TUBING AND CASING

40,000' 2⅜" OD 4# Good Used Lapweld Range 1 T&C Tubing, 11½ V-Threads
15,000' 2⅜" OD 4# Good Used Lapweld Range 1 T&C, New 10 Round Thread
30,000' 2⅜" OD 4.6# Once Run Seamless Range 2 Tubing, 10 Round Thread
20,000' 2⅞" OD 6.4# Once Run Seamless Range 2 Tubing, 10 Round Thread
25,000' 5½" OD 14# Good Used Lapweld Casing, Range 1, 11½ V-Threads
10,000' 5½" OD 17# Good Used Lapweld Casing, Range 1, 11½ V-Threads
50,000' 7" OD 17# Good Used Lapweld Casing, Range 1, 10 V-Thread
35,000' 7" OD 20# Good Used Lapweld Casing, Range 1, 10 V-Thread

SUBJECT TO PRIOR SALE

OTHER SIZES NEW AND USED CASING, TUBING, LINE PIPE AND SEAMLESS TUBING . . . MANY SIZES SUITABLE FOR GAS, OIL, WATER FLOW LINES.
FOR FULL DETAILS, WIRE OR PHONE AT ONCE

A. J. STRUBEL, Broker

SIDney 1791 (Day Phone) HUDson 8152 (Night Phone) 4946 Murdoch, St. Louis, Mo.

EQUIPMENT FOR SALE

FOR CABLE TOOLS
DEGEN PIPE AND SUPPLY CO.
Box 107, Red Fork Station, Tulsa, Oklahoma

FOR SALE: At our Sasakwa Gasoline Plant: 1—Fluor Cooling Tower, 10 bays high, 5 bays wide. Cities Service Oil, Patridge, Bartlesville, Oklahoma.

EQUIPMENT FOR SALE

2—Identical Electric Machinery Manufacturing Company Generators, 60 KVA, 40 KW, 480V, 60 AMP, 1200 RPM, 3 Phase, 60 Cycle, each powered by a Buda Model L525 natural gas or gasoline engine and each cooled by a Young Happy Model 36 Full Flow Engine Jacket Water Cooler. Horsting Oil Company, P. O. 388, Driscoll, Texas.

EQUIPMENT FOR SALE

FOR SALE: At Oklahoma City Warehouse, 1 Allis-Chalmers Model UM-4 Skid Type Well Servicing Winch, $950.00. No mast—Cities Service Oil, Patridge, Bartlesville, Oklahoma.

FOR SALE OR TRADE: 16000′ New 7″ OD 20# J-55 R-2, 8R, seamless casing. Big Mill Pipe. Sabine Machine & Supply Co., Phone 3094, P. O. Box 111, Kilgore, Texas.

125 KW, 514 RPM, 3-phase, 60-cycle, 480 volts, Engine Type, Electric Machinery Generator, direct connected exciter. Alfred B. Kern, 223 Wright Bldg., Tulsa, Oklahoma.

CABLE RIG for 6,000′ on tandem truck. Bargain. Located Tonkawa, Oklahoma. Contact: G. M. McLaughlin, 3506 West Pikes Peak, Colorado Springs, Colorado. Phone 6887-J.

FOR SALE: New Buda Gas-Gasoline Oil Field Power Units, Models 4MO-645 & 6MO-893, for complete details write Box 248, Mt. Pleasant, Michigan.

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2. **EMSCO GA-500** Ideco 136′ mast, National C-350 and G-D FXQ pumps. Two GM Twin diesels on draw works and FXQ pump. One GM Quad diesel on C-350 pump.
3. **EMSCO J-750** Ideco 136′ mast, G-D FXL and Emsco P-16 pumps. Three GM Twin diesels on draw works, power takeoffs to both pumps, two GM Quad diesels, one on each pump.
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CONSTRUCTION Superintendent: Must be experience in Industrial Construction including Chemical and Refinery Plants. Good opportunity and future in well established small company. In applying state education, experience, family status and salary expected. Work is in the Houston area. Box D-988, The Oil and Gas Journal, Tulsa, Oklahoma.

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Exploratory Geologist familiar with and preferably now residing in Southern Oklahoma. Must be aggressive and experienced. Fine opportunity with progressive Independent.

Box D-967, The Oil and Gas Journal
Tulsa, Oklahoma

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Box D-965, The Oil and Gas Journal,
Tulsa, Oklahoma

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To be located in Tulsa, Oklahoma, to work on projects in Petroleum and Petro-Chemical field. Operating experience desirable but not required.

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Engineer

OFFICE ENGINEER

The Atlantic Refining Company of Brazil requires an Engineer with demonstrated ability to handle such office assignments as: supervision of detailing, estimating construction and maintenance costs, writing specifications and ordering construction materials, electrical and mechanical equipment. Experience on petroleum products, bulk storage and sales facilities desired. Minimum of 5 years' office engineering experience required. Starting salary depending on qualifications. Write stating education, experience and personal qualifications to

MR. E. T. ADDISON
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260 SOUTH BROAD STREET
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Box D-983

The Oil and Gas Journal

Tulsa, Oklahoma

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ATTENTION: Well established oil well drilling contractor desires to manage and supervise: Individuals', groups', small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas, and New Mexico. Personal interview by appointment is desired. Makin Drilling Company, Box No. 131, Ph. No. 131, Hobbs, New Mexico.

DRILLING Contractor operating in West Texas and New Mexico desires to contact small or medium-sized independent oil company who needs an operating manager. Personal interview desired. Twenty years experience in all phases of the oil industry. Address replies to Box D-644, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOPHYSICIST 15 years experience available July seeks permanent location supervising interpreting reviewing seismic gravity magnetics in Caribbean Area, Brazil, Mexico, Peru. Box D-937, The Oil and Gas Journal, Tulsa, Oklahoma.

FORMER Independent Oil Operator ten years, with legal education, plus eight years Wall Street experience, desires connection raise funds exploratory well drilling from excess profits taxpayers. Box D-938, The Oil and Gas Journal, Tulsa, Oklahoma.

PUBLIC ACCOUNTANT located in Tulsa can handle additional part time bookkeeping and tax clients. 25 years' experience. P. O. Box 812, Tulsa, Oklahoma.

ESTABLISHED Factory Representative covering North and East Texas desires additional lines, applicable oil, industrial, sold thru supply stores. Write—Box 316, Crockett, Texas.

SUBSURFACE GEOLOGIST — Independently Maintaining Current Assembly of Regional Subsurface Structural Contour Maps of Central and Eastern Oklahoma Desires to Become Associated with Oil Operator on Variable Basis. P. O. Box 1884, Tulsa.

SALES ENGINEER—Manufacturer's representative. Sixteen years experience in technical sales and contract negotiation. Graduate engineer, age 40. Box D-984, The Oil and Gas Journal, Tulsa, Oklahoma.

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Desires to represent company as

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KANSAS OIL DEALS WANTED: Reputable independent operator and producer solicits your drilling deals. Box D-974, The Oil and Gas Journal, Tulsa, Oklahoma.

OIL DEALS WANTED
Independent Operators seeking immediate drilling deals with good geology. Box D-972, The Oil and Gas Journal, Tulsa, Oklahoma.

PLANNING to develop a partly proven oil-gas field in Allegany County, N. Y. Interest may be had for cash or good used casing, drive pipe and well equipment. If interested, write for details. C. N. Wilber, Box 625, Westfield, Pa.

FOR SALE: Oil and Gas Leases adjoining producing leases, also wildcat leases, Drilling propositions and small producing properties; all in shallow territory. W. P. Harley, Bowling Green, Ky.

WANT—Producing oil, gas, or mineral leases, royalties; mortgages on all kinds of properties; $20,000 to $2,000,000; all locations U. S., Canada or Mexico. Owners, Brokers, what have you? John Stouppas, 175 E. Long St., Columbus, Ohio.

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Bought and Sold—Any Area
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Portales, New Mexico

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PATENT Practice before U. S. Patent Office. Validity and Infringement Investigations and Opinions. Booklet and form "Evidence of Conception" forwarded upon request. Lancaster, Allwine & Rommell, Registered Patent Attorneys, Suite 418, 815-15th Street, N.W., Washington 5, D. C.

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Cresap Joins Westinghouse

Mark W. Cresap, Jr., management consultant, has joined Westinghouse Electric Corp., Pittsburgh, as a vice president and assistant to Gwilym A. Price, president.

Cresap is a cofounder of the New York and Chicago management consultant firm of Cresap, McCormick & Paget.

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